SECTION 9

INCREMENTAL INVESTMENT AND OPERATING AND MAINTENANCE COSTS FOR PROPOSED REGULATION

This section presents EPA's estimates of incremental investment costs and incremental operating and maintenance costs for the industry to comply with each regulatory option considered for the proposed rule. EPA estimated the compliance costs for each technology option to determine potential economic impacts on the industry and to weigh these costs against the effluent reduction benefits resulting from the proposed technology option. All estimates are based on data collected for the calendar year 1997. Section 10 presents Agency estimates of annual pollutant loadings and removals for each technology option. The Agency is reporting estimates of potential economic impacts associated with the total estimated annualized costs of the proposed regulation separately (Reference 9-1).

Section 9.1 describes EPA's methodology to estimate costs to achieve the effluent quality for each technology option in each subcategory (Section 8 discusses these options). Section 9.2 summarizes the results of the cost analyses, by subcategory, for each technology option evaluated.

9.1 Methodology

EPA developed site-specific cost estimates using data collected from industry survey responses and Agency site visits and sampling episodes. Section 3 provides more information on Agency data collection efforts. EPA also solicited data from vendors of various wastewater treatment technologies, obtained data collected by state agencies, surveyed the technical literature, and enlisted the services of a design and engineering firm that has installed wastewater treatment equipment in the iron and steel industry.

As discussed in Section 8, the Agency developed technology options for each iron and steel subcategory. EPA established a pollution control performance standard for each technology option based on the following components:

- ***Effluent concentrations.*** EPA identified sites with treatment technologies representing each technology option and then evaluated these data to identify sites with the best wastewater treatment performance. The Agency evaluated long-term average effluent concentrations from the analytical data from sites with the best wastewater treatment performance to develop model effluent concentrations. Using this same dataset, EPA calculated long-term averages and variability factors for the development of limitations (see Section 12). For each technology option, EPA compared the model effluent concentrations with effluent concentrations provided by each site to assess wastewater treatment performance.

- ***Technology in place.*** EPA considered the in-process controls and end-of-pipe treatment units comprising each technology option as model pollution control technologies. EPA evaluated industry survey responses to determine wastewater treatment technologies used at sites. The Agency compared model treatment with technology in place at sites to measure wastewater treatment performance. For some survey respondents, available analytical data for outfalls contained substantial amounts of noncontact cooling water or nonprocess wastewater. In these cases, the Agency used technology-in-place solely to assess wastewater treatment performance. Tables 8-3 through 8-9 in Section 8 summarize the results of the technology in place analysis for each iron and steel subcategory.

- ***Production-normalized flow rates (PNFs).*** The Agency developed model PNFs representing appropriate process water management and water conservation practices for each technology option, with emphasis on high-rate recycle. When developing model PNFs, the Agency took into account the nature of subcategory process operations, the rates at which water was applied to processes, recirculating process water quality requirements, and good water management practices. For more information on the development of model PNFs, refer to Section 7. For each technology option, the model PNFs were compared with PNFs calculated from industry survey responses to assess water management practices at sites.

The Agency analyzed these components of pollution control performance to judge whether wastewater treatment units, entire treatment systems, or modifications in operating practices would be necessary for individual sites to achieve model effluent concentrations and PNFs with a particular technology option. If EPA determined that a site exceeded model effluent concentrations or PNFs, the Agency compared the technology in place at the site with the model treatment system of the technology option. EPA then determined the amount of investment, operating and maintenance, and/or one-time costs for those equipment items, water management practices, or operating and maintenance practices that were not consistent with the model treatment systems. There are many possible combinations and variations of the treatment system components of the technology options considered that sites can use to achieve the proposed limitations and standards. Not all sites would be required to install all of the treatment system components to achieve model effluent concentrations and PNFs. For the purposes of preparing these cost estimates, EPA assumed that sites not achieving the model effluent concentrations and PNFs would install treatment identical to the corresponding technology option.

EPA developed a computerized design and cost model to estimate costs using the methodology described above. Sections 9.1.1, 9.1.2, and 9.1.3 describe how EPA developed cost equations for use in the cost model to estimate investment, operating and maintenance, and one-time costs associated with various treatment technologies, respectively. For certain hot forming, continuous casting, and blast furnace operations lacking high-rate recycle systems, EPA

developed cost estimates on a site-specific basis independent of the cost models noted above (see Section 9.1.1).

EPA estimated costs for the iron and steel industry for the base year 1997. The Agency included sites that operated during the 1997 calendar year in the cost analysis if they met the following criteria:

- If a site operated at least one day during the 1997 calendar year; and
- If a site (or operation) shut down after 1997.

If a site (or operation) commenced operations after 1997, EPA did not include the site (or operation).

For some sites, 1997 data did not represent normal operating conditions; for those sites, EPA used data from alternate years. Several sites operated only part of 1997 because of strikes, shut downs, or start-ups. For these sites, EPA used production, analytical, and flow rate data from years that the sites indicated reflected normal operations. If sites installed or significantly altered wastewater treatment systems either during or after 1997, EPA used the data that represented the most current wastewater treatment configuration.

EPA excluded from the cost analysis sites reporting zero discharge of wastewater. The Agency assumed that these sites can continue to operate in this manner and will therefore achieve model effluent concentrations and PNFs.

9.1.1 Investment Costs

For each wastewater treatment facility in each subcategory, EPA determined the equipment items required to achieve the model effluent concentrations and PNFs following the methodology described in Section 9.1. Agency investment cost estimates include costs for the following components:

- ***Equipment:*** Purchased equipment items, including freight;

- ***Installation:*** Mechanical equipment installation, piping installation, civil/structural work (site preparation and grading, construction of equipment foundations and structural supports), costs for materials and labor to construct buildings or enclosed shelters, and electrical and process control instrumentation;

- ***Indirect costs:*** Costs for temporary facilities during construction and installation, spare parts, engineering procurement and contract management, commissioning and start-up, and labor costs for site personnel to oversee equipment installation (owner team costs); and

- ***Contingency***: Additional costs included in estimates to account for unforeseen items in vendor and/or contractor estimates.

The Agency developed investment cost estimates using data sources discussed below:

- ***Vendor and Capital Cost Survey Data.*** The Agency developed cost estimates for purchased equipment and ancillary equipment (pumps, piping, sumps, etc.) for various sizes of technology option components using data from capital cost survey responses and vendor quotes.

- ***Engineering and Design Firm***. EPA used a design and engineering firm for cost factors to estimate costs associated with the following: shipping of equipment, labor for mechanical equipment installation, site preparation and grading, equipment foundations and structural support, buildings to house treatment equipment and provide enclosed shelter, purchase and installation of piping, and electrical and process control instrumentation. Table 9-1 lists the cost factors used to estimate installed costs of individual treatment units. These cost factors are based on an evaluation of past project costs and budgetary estimates for wastewater treatment installations in the iron and steel industry. The Agency estimated the investment costs of treatment units for various design flow rates by multiplying the purchased equipment cost by approximately 3.5. EPA then plotted the investment cost versus the design flow rate to develop cost equations for use in the computerized cost model. The Agency assumed a linear relationship between investment costs and flow rates, where the range of flows was relatively low. For treatment units that were costed across a wide range of flow rates, EPA extrapolated separate lines for incremental flow ranges. Otherwise, the Agency used the median cost per gallon per minute to estimate investment costs. A detailed summary of the individual treatment units is provided in the Iron and Steel Administrative Record.

  EPA also used an engineering and design firm to estimate investment costs for design flow rates spanning the range of actual industry flow rates for the following treatment systems:

  — Granular activated carbon filtration of cokemaking wastewater (component of BAT-4, By-Product Cokemaking Segment);

  — Alkaline chlorination of cokemaking wastewater (component of BAT-3 and PSES-4, By-Product Cokemaking Segment);

— Metals precipitation of blast furnace and sintering wastewater (component of BAT-1 and PSES-1, Ironmaking Subcategory);

— Alkaline chlorination of blast furnace and sintering wastewater (component of BAT-1, Ironmaking Subcategory);

— Metals precipitation of basic oxygen furnace steelmaking, vacuum degassing, and continuous casting wastewater (component of BAT-1 and PSES-1, Integrated Steelmaking Subcategory; and BAT-2, Non-Integrated Steelmaking and Hot Forming Subcategory); and

— Polishing of wastewater through multimedia filtration (component of BAT-4, By-Product Cokemaking Segment; BAT-1, Ironmaking Subcategory; BAT-1 and PSES-1, Integrated and Stand-Alone Hot Forming Subcategory; and BAT-1 and PSES-1, Non-Integrated Steelmaking and Hot Forming Subcategory).

The engineering and design firm developed investment costs for these treatment systems by determining equipment requirements and specifications according to the specified design flow rates. The firm did not use cost factors to estimate installation costs; instead, it provided line-item estimates for mechanical equipment installation, piping installation, equipment foundations (including site preparation and grading), equipment structural support, buildings, and electrical and process control instrumentation. Figures 9-1 through 9-6 present these treatment systems and Table 9-4 presents the assumptions used to develop these cost estimates. Tables 9-5 through 9-16 present corresponding design specifications and itemized cost sheets. EPA then developed cost curves and model equations as described above.

Table 9-2 summarizes the investment cost equations used to estimate costs for technology option components, the applicable subcategories and technology options, and the sources of these estimates.

EPA identified several sites with once-through wastewater treatment systems that would need to invest in high-rate recycle systems to achieve model PNFs. EPA determined equipment items necessary to achieve high-rate recycle and gathered site-specific information from Agency surveys, site visits, and sampling episodes conducted during this rulemaking. Because these systems are complex and not amenable to a standardized costing approach, the Agency requested the engineering and design firm to estimate investment costs on a site-specific basis using available site-specific information and data.

When estimating costs for sites for entire high-rate recycle or wastewater treatment systems, the Agency took into account land availability, when possible. For sites for which EPA estimated costs for add-on technologies to existing wastewater treatment systems, the Agency assumed that additional space for those technologies was available.

EPA sized wastewater treatment components for each site according to flow rates reported in the industry survey responses. When industry survey responses indicated that existing treatment systems also treated nonprocess water such as ground water, storm water, or noncontact cooling water, the Agency also considered those flows. For sites that EPA estimated would install new blowdown treatment systems to achieve model treatment system effluent quality, the Agency sized these blowdown treatment systems according to model PNFs (in gallons per ton). Blowdown treatment systems were sized according to the flow rate determined by multiplying a site's reported production rate by the model PNF.

9.1.2 Operating and Maintenance Costs

EPA developed estimates of incremental operating and maintenance costs by evaluating operating and maintenance cost data from the detailed and short surveys, supplemented with data from other sources. EPA used specific data from survey responses whenever possible. The Agency estimated operating and maintenance costs for the following items:

- ***Labor.*** Labor costs associated with general operating and maintenance of treatment equipment. EPA used a labor rate of $29.67 per hour to convert the labor requirements of each technology into annual costs which it determined by the following. The Monthly Labor Review, which is published by the U.S. Bureau of Labor Statistics of the U.S. Department of Labor (Reference 9-2), provided the base labor rate. The Agency averaged monthly values for 1997 for production labor in the blast furnace and basic steel products to obtain a base labor rate of approximately $20.90 per hour. Forty-two percent of the base labor rate was then added for overhead (e.g., health insurance, vacation) to obtain the $29.67-per-hour labor rate. Industry survey responses indicated labor rates between $13.00 and $85.64. The median labor rate reported by industry surveys was $28.95. Data collected from the industry survey, site visits, and other contacts with the industry show that the great majority of wastewater treatment systems are staffed on a 24-hour basis. This includes complex wastewater treatment systems for by-product recovery cokemaking, ironmaking, and steelmaking operations; hot forming operations with mechanical treatment systems; and steel finishing operations where wastewater from multiple processes are cotreated. Consequently, the Agency used 24-hour staffing as the baseline labor staffing complement, where reported. Incremental labor costs associated with the assigned wastewater treatment system upgrades were estimated and added to the baseline labor costs to assess incremental cost impacts of the proposed regulation.

- ***Maintenance.*** Costs (excluding labor costs) associated with upkeep of equipment, repairs, operating supplies, royalties, and patents. When these costs could not be estimated based on industry survey responses, the Agency assumed annual maintenance costs to be 6 percent of the investment cost of equipment (Reference 9-3). Maintenance costs reported by industry ranged from 0.2 percent to 6.3 percent of investment costs. The median maintenance cost, as a percentage of investment costs, reported by industry was 1.1 percent.

- ***Chemicals.*** Costs for chemicals used for various wastewater technologies. EPA evaluated industry survey responses to determine chemical usage rates for well-operated treatment systems. When these costs could not be estimated based on industry survey responses, the Agency obtained chemical prices from the Chemical Marketing Reporter from December 1997 (Reference 9-4).

- ***Energy.*** Energy requirements and costs associated with operation of treatment equipment. In general, additional energy requirements were a result of new or upgraded high-rate recycle and treatment systems having electric motors to drive water pumps, chemical mixers, aeration equipment such as blowers and compressors, and cooling tower fans. When energy costs for equipment could not be estimated based on industry survey responses, EPA obtained electricity prices from the U.S. Department of Energy's Energy Information Administration's Average Industrial Electrical Costs in 1998. The average electrical cost to industrial users between 1994 and 1997 was $0.047 per kilowatt hour (kWh) (Reference 9-5). Section 13 presents the estimated energy requirements for each technology option and a more detailed discussion of methodology. The median electrical cost reported in industry surveys was $0.04 per kWh.

- ***Sludge/Residuals (Hazardous/Nonhazardous) Disposal.*** Cost of disposing of generated sludge. The Agency calculated incremental sludge generation rates associated with each technology option. Section 13 presents the methodology and results for this analysis. After considering sludge generation rates, sludge disposal destinations, and sludge disposal costs, the Agency determined that the incremental cost associated with sludge disposal from these technology options is minimal. Therefore, EPA has not included costs associated with sludge disposal in cost estimates for the proposal, except for incremental costs associated with sludge disposal of technology options PSES-3 and PSES-4 of the By-Product Segment of the Cokemaking Subcategory. The Agency calculated site-specific sludge disposal costs for these technology options because several sites would generate and dispose of sludge associated with biological treatment, where no sludge of this nature was previously generated at the site.

- ***Sampling/Monitoring.*** Sampling and monitoring costs to determine compliance with permits or performance of treatment systems. Because of the operational complexity associated with alkaline chlorination, biological treatment, and cyanide precipitation, the Agency estimated additional costs to sample and monitor treatment performance. EPA estimated additional compliance sampling and monitoring costs for dioxins and furans, which are not currently regulated under 40 CFR 420, for sinter plants because of the significant costs associated with these analyses. These costs were estimated to be $12,000 per year per site. For other pollutants such as thiocyanate, mercury, selenium, and fluoride that are not currently regulated under 40 CFR 420, the Agency did not estimate incremental sampling and monitoring costs because many of these pollutants are currently sampled and monitored by sites because of water quality standards. Moreover, the Agency did not incorporate monitoring cost savings realized by sites because of the elimination of naphthalene, tetrachloroethylene, and benzene as a result of the proposed regulation.

Table 9-3 presents the equations used to calculate individual equipment operating and maintenance costs, along with the range over which the equations have been developed. The table provides information sources for each of the cost equations in the footnotes. A more detailed description of the development of these costs for each equipment item is provided in the Iron and Steel Administrative Record.

9.1.3 One-Time Costs

When assessing costs for technology options consisting of biological treatment, chemical precipitation, or multimedia filtration, EPA found that analytical data from some survey responses showed that, despite the facilities having technology in place equivalent to a technology option, their PNFs or effluent concentrations exceeded model values. In such cases, the Agency evaluated treatment system design and operating parameters to determine additional investment and operating and maintenance costs required to achieve the model PNFs and effluent quality. If design and operating parameters were equivalent to model treatment operating parameters or when these parameters were not provided in a site's survey response, the Agency allocated a single-occurrence cost associated with hiring an outside consultant to upgrade wastewater treatment system performance (e.g., improve site operation and maintenance to optimize biological treatment system performance). For chemical precipitation systems, the Agency also assumed a 15 percent increase in operating and maintenance costs (primarily due to additional chemical use).

For technology options incorporating high-rate recycle, EPA evaluated production-normalized flow rates and recycle technology in place to determine whether a site required investment and operating and maintenance costs to achieve the model PNFs. The Agency found many instances where facilities have installed high-rate recycle systems, but the discharge flow rates exceed the selected model discharge flow rates on a production-normalized

basis. If the system was able to recirculate the incremental flow necessary to achieve the model PNF, EPA did not assign an investment cost for new facilities in the main treatment and recycle circuit. In cases where the increase in recycle rate was minimal with respect to the total recirculating flow rate, EPA assigned a one-time cost for consultant and mill services to evaluate the treatment and recycle system and to modify water management practices and operations to achieve the model discharge flow rate. If the treatment and recycle system lacked sufficient hydraulic capacity to recirculate the incremental flow necessary to achieve the model discharge flow rate, EPA sized and costed additional process water treatment and recycle facilities for the main treatment and recycle circuit. The Agency assumed that the one-time costs would include relatively minor costs associated with controlling make-up water flow rates and eliminating sources of extraneous water. Incremental operation and maintenance costs were not assigned. The Agency assumed the increased costs associated with modifying the recycle rate would be minimal and offset by likely savings in process water chemical treatment.

EPA assumed these one-time costs for minimal improvements in wastewater treatment performance or recycle rates to be $50,000. This estimate is based on a 10-week study, comprising 400 hours of direct labor (160 hours of field work and 240 hours of office work) at a labor rate of $100 per hour, approximately $5,000 for airfare, food, lodging, and other direct costs (equipment rental, analytical costs, telephone costs), and $5,000 for miscellaneous expenses.

9.2 Results

This section presents Agency national estimates of incremental investment and operating and maintenance costs by technology option for each industry subcategory. Agency cost estimates for this rulemaking are factored estimates and are considered to be accurate within ±25 to ±30 percent (Reference 9-3).

9.2.1 Cokemaking Subcategory - By-Product Segment

The Agency estimated the cost impacts of four BAT and PSES technology options for 22 by-products recovery cokemaking sites in the United States that discharge wastewater. Of these 22 sites, 14 are direct dischargers and 8 are indirect dischargers. The table below summarizes the technology options evaluated. Agency cost estimates for these options are discussed in the subsections below and presented in Table 9-17.

Technology Options for By-Product Segment

Treatment Unit	BAT-1	BAT-2	BAT-3	BAT-4	PSES-1	PSES-2	PSES-3	PSES-4
Tar/oil removal	✔	✔	✔	✔	✔	✔	✔	✔
Equalization/ammonia still feed tank	✔	✔	✔	✔	✔	✔	✔	✔
Free and fixed ammonia still	✔	✔	✔	✔	✔	✔	✔	✔
Temperature control	✔	✔	✔	✔			✔	✔
Cyanide precipitation with sludge dewatering		✔				✔		
Equalization tank	✔	✔	✔	✔			✔	✔
Biological treatment with secondary clarification	✔	✔	✔	✔			✔	✔
Sludge dewatering	✔	✔	✔	✔			✔	✔
Alkaline chlorination (2-stage)			✔	✔				✔
Multimedia filtration				✔		✔		
Granular activated carbon				✔				

BAT-1

EPA analyzed long-term average effluent data and wastewater treatment operating parameters provided in industry survey responses from all 14 direct discharging sites. Based on this analysis, EPA made the estimates discussed below.

One site would install additional aeration capacity for biological treatment to achieve the model treatment concentration for ammonia as nitrogen. The Agency believes that the current operating hydraulic retention time (HRT) and solids retention time (SRT) at this site are insufficient to consistently achieve model treatment concentrations. Consequently, the Agency estimated investment costs for additional biological treatment basin capacity required to achieve a 50-hour HRT and an SRT of 100 days, which are based on industry survey responses from by-product cokemaking sites with model treatment and performance. EPA also estimates that this site would incur a one-time cost to reduce the use of control water and would install an equalization tank ahead of existing ammonia stills to minimize influent and effluent variability for ammonia-N.

The Agency also estimates that:

- One site would incur a one-time cost to reduce the use of control water and install a heat exchanger prior to biological treatment, to ensure proper temperature control;

- One site would incur a one-time cost to reduce the use of control water; and

- Three sites have model treatment technology in place, but would incur a one-time cost to improve the operation of existing biological treatment systems.

One site does not operate biological treatment following ammonia distillation. Instead, this site operates an ammonia still followed by a dephenolization system, sand filtration, and granular activated carbon filtration. The Agency assumed that the owner or operator of this site would replace the existing physical chemical treatment system with a biological treatment system to achieve ammonia as nitrogen and total phenol model treatment concentrations. Although this would require an investment of approximately $4 million, the Agency estimates that this site would realize annual operating and maintenance cost savings.

The Agency estimates that the remaining seven sites have existing wastewater treatment systems that would achieve compliance with BAT-1 model effluent concentrations and PNFs. Therefore, EPA estimates that these sites would not incur any costs to comply with BAT-1.

BAT-2

In addition to the costs associated with complying with BAT-1, EPA estimates that eight sites would install a cyanide precipitation system. Effluent total cyanide concentrations reported in industry survey responses indicate that these sites would not achieve model effluent concentrations. Six sites discharge wastewater with total cyanide concentrations below the model BAT-2 effluent concentrations and would not require this technology.

BAT-3

In addition to the costs associated with BAT-1, EPA estimates that all 14 direct discharge sites would install alkaline chlorination systems to achieve BAT-3 model effluent concentrations and PNFs.

BAT-4

In addition to the costs associated with BAT-3, EPA estimates that 11 sites would install granular activated carbon systems and nine sites would install multimedia filtration systems to comply with BAT-4. Two sites use sand or multimedia filtration systems and two sites operate sand filters followed by granular activated carbon filters. One site operates a granular activated carbon filtration as a bypass system and has sufficient design capacity to treat its effluent.

PSES-1

Of the eight indirect discharging sites, three use biological treatment. Two sites operate an ammonia still followed by cyanide precipitation; one of these sites also operates a sand filtration system following cyanide precipitation. The remaining three sites operate an ammonia

still. The Agency estimates that two sites would incur a one-time cost to improve ammonia still performance, and would increase annual operating and maintenance costs by 15 percent for additional steam consumption. The Agency estimates that three sites with conventional activated sludge systems would incur a one-time cost to improve biological treatment system performance.

PSES-2

In addition to the costs associated with PSES-1, the Agency estimates that four sites would install cyanide precipitation and multimedia filtration systems to comply with PSES-2. Four sites can achieve PSES-2 model effluent concentrations and PNFs for ammonia, cyanide, and benzo-a-pyrene. Therefore, EPA estimates that these sites would not incur any cost as a result of complying with PSES-2.

PSES-3

The Agency estimates that five sites would install biological treatment systems to comply with PSES-3. The Agency estimated investment costs of installing biological treatment systems designed and operated based on a 50-hour HRT and an SRT of 100 days, along with associated equalization, clarification and sludge handling systems. EPA also estimates that three sites with existing biological treatment would incur a one-time cost to improve system performance.

PSES-4

EPA estimates that, in addition to the costs incurred to comply with PSES-3, all eight indirect discharging sites would install alkaline chlorination systems to achieve PSES-4 model effluent concentrations and PNFs.

Non-Recovery Segment

The Agency is aware of one non-recovery cokemaking plant that operated in 1997. This site does not discharge process wastewater and would therefore not incur any additional costs to achieve zero discharge.

9.2.2 Ironmaking Subcategory

Of the 20 integrated sites in the United States, 9 discharge blast furnace wastewater only and three discharge blast furnace and sintering wastewater. The Agency is aware of one stand-alone sinter plant that operated in 1997 and discharged wastewater. Of the 14 sites that discharge blast furnace or sinter plant wastewater, 9 operated dedicated blast furnace treatment systems (one is an indirect discharging site); 3 operated combined sintering and blast furnace treatment systems, 1 co-treated wastewater from sintering, blast furnace, and other iron and steel manufacturing processes, and 1 operated a dedicated sinter plant treatment system. Of the 14 sites with blast furnace ironmaking operations that discharge wastewater, 10 sites had

Clean Water Act section 301(g) variances for ammonia and phenol (see Section 15). The Agency assumed that sites with these variances in existing permits would reapply for and be granted 301(g) variances during permit renewal. Therefore, EPA did not estimate costs for alkaline chlorination systems to achieve BAT-1 model treatment for sites with cyanide concentrations below or equivalent to BAT-1 model treatment concentrations. The table below summarizes the technology options for treatment of blast furnace and sintering wastewater, whether co-treated or treated separately. Agency cost estimates for these options are discussed in the subsection below and presented in Table 9-18.

Technology Options for Ironmaking Subcategory

Treatment Unit	BAT-1	PSES-1
Clarifier	✔	✔
Sludge dewatering	✔	✔
Cooling tower (blast furnace only)	✔	✔
High-rate recycle	✔	✔
Blowdown treatment		
Metals precipitation	✔	✔
Alkaline chlorination (2-stage)	✔	
Multimedia filtration	✔	

BAT-1/PSES-1

EPA evaluated industry survey responses from 13 direct discharging sites and one indirect discharging site. The Agency estimates that two sites with existing once-through treatment systems would install high-rate recycle systems to achieve model treatment. Based on effluent concentrations reported in the survey responses for lead and zinc, the Agency assumed one of these sites would also install a blowdown treatment metals precipitation system to achieve model treatment concentrations. To estimate the investment costs for these high-rate recycle systems, the Agency used site knowledge and an engineering and design firm to estimate investment costs (independent of the cost model) for each site.

In addition to the wastewater treatment modifications above and after taking Section 301(g) variances into consideration, the Agency also estimates that:

- One site would install a blowdown treatment system comprising metals precipitation, solids handling, alkaline chlorination, and multimedia

filtration to achieve model effluent concentrations and incur a one-time cost to achieve the model PNF.

- One site would install a blowdown treatment system comprising alkaline chlorination and multimedia filtration system and incur a one-time cost to improve its existing metals precipitation system. Based on chemical usage rates reported by this site, EPA estimates that annual operating and maintenance costs would increase by 15 percent.

- One site would install a multimedia filtration system to achieve model lead and zinc concentrations.

- One site would install a blowdown metals precipitation system and solids handling system prior to an existing sand filtration system.

- One site would install a multimedia filtration and solids handling system and incur a one-time cost for flow reduction of blast furnace and sintering operations.

- One site would install a blowdown metals precipitation, solids handling, and multimedia filtration system to achieve model lead and zinc concentrations and incur a one-time cost to achieve the model PNF for discharge of sintering wastewater.

- One site would install a blowdown metals precipitation, solids handling, and multimedia filtration system to achieve model lead and zinc concentrations and incur a one-time cost to achieve the model PNF.

- One site would incur a one-time cost for to reduce flow and install a multimedia filtration system.

- Two sites would incur a one-time cost to modify operating practices of existing metals precipitation systems. Based on chemical usage rates reported by these sites, EPA estimates that annual operating and maintenance costs would increase by 15 percent.

- Two sites would incur a one-time cost to reduce flow and improve operation of its existing metals precipitation system.

9.2.3 Integrated Steelmaking Subcategory

According to industry survey responses, there are 20 integrated sites with basic oxygen furnaces (BOFs) and continuous casting operations. Thirteen of these sites have vacuum degassing operations. The Agency is also aware of one non-integrated site that operates a BOF. EPA estimated incremental costs for these 21 sites. The table below summarizes the technology options for treatment of wastewater from BOF, vacuum degassing, and continuous casting operations, whether co-treated or treated separately. Agency cost estimates for these options are discussed in the subsection below and presented in Table 9-19.

Technology Options for Integrated Steelmaking Subcategory

Treatment Unit	BAT-1	PSES-1
Classifier (BOF only)	✔	✔
Scale pit with oil skimming (continuous casting only)	✔	✔
Clarifier	✔	✔
Sludge dewatering	✔	✔
Multimedia filtration[a] (continuous casting only)	✔	✔
Cooling tower (vacuum degassing and continuous casting)	✔	✔
High-rate recycle	✔	✔
Blowdown treatment		
Metals precipitation	✔	✔

[a] May be used in recycle circuit or as blowdown treatment.

BAT-1/PSES-1

The Agency estimates that 8 of the 21 sites would install blowdown metals precipitation systems to achieve BAT-1/PSES-1 model treatment concentrations and incur one-time costs to achieve model PNFs. EPA estimates that two of these sites would invest additional capital to reroute existing discharges to these add-on metals precipitation systems. Based on site visits and information provided in industry survey responses, the Agency estimates that approximately 300 feet of piping would be required to reroute this wastewater at both sites and estimates an additional $250,000 of investment costs at each site to purchase and install this piping.

The Agency is aware of one site that performs once-through treatment of continuous casting wastewater. To estimate the investment costs to install a high-rate recycle

system at this site, the Agency used site knowledge and an engineering and design firm to estimate investment costs independently of the cost model.

In addition to the wastewater treatment modifications mentioned above, the Agency also estimates that:

- One site would install a blowdown metals precipitation system to achieve model treatment.
- One site would incur a one-time cost to improve the operation of its existing metals precipitation system. Based on chemical usage rates reported by this site, EPA estimates the site would increase annual operating and maintenance costs by 15 percent.
- The Agency believes that one site would not incur any costs as a result of complying with BAT-1 and that nine sites would achieve BAT-1 model PNFs after incurring one-time costs.

9.2.4 Integrated and Stand-Alone Hot Forming Subcategory

The Agency estimates that 44 carbon steel integrated and stand-alone hot forming sites discharge wastewater to surface water in the United States and seven sites discharge wastewater to POTWs. EPA estimates that the three integrated and stand-alone hot forming sites that manufacture stainless steel products are indirect discharging sites. No survey respondent with stainless steel hot forming operations reported direct discharge of wastewater.

The table below summarizes the technology options evaluated for the carbon and alloy and stainless segments of this subcategory. Agency cost estimates for these options are discussed in the subsections below and presented in Table 9-20.

Technology Options for Integrated and Stand-Alone Hot Forming Subcategory

Treatment Unit	BAT-1	PSES-1
Scale pit with oil skimming	✔	✔
Roughing clarifier with oil removal	✔	✔
Sludge dewatering	✔	✔
Multimedia filtration[a]	✔	✔
High-rate recycle	✔	✔
Blowdown treatment		
Multimedia filtration[a]	✔	✔

[a] May be used in recycle circuit or as blowdown treatment.

BAT-1 (Carbon and Alloy Segment)

The Agency estimates that 12 sites would install high-rate recycle systems to replace existing partial or once-through treatment systems. To estimate the investment costs to install a high-rate recycle system for 10 of these sites, the Agency used site knowledge and an engineering and design firm to estimate investment costs independently of the cost model. EPA also estimated costs for one of these sites to segregate hot forming and finishing wastewater that was co-treated in an end-of-pipe system. The Agency distributed costs associated with this modification to the Integrated and Stand-Alone Hot Forming Subcategory and Steel Finishing Subcategory according to the relative percentage of wastewater flow reported by this site from both subcategories. The Agency used the cost model to estimate investment costs for the other two sites with once-through treatment systems. EPA also estimates that one site would invest approximately $2 million to reroute hot forming wastewater discharge to an existing sand filtration system.

In addition to the wastewater treatment modifications mentioned above, the Agency also estimates that:

- Ten sites would incur one-time costs to achieve model PNFs;
- Two sites would incur one-time costs to improve operation of existing multimedia filtration systems to achieve model effluent concentrations;
- Five sites would install blowdown multimedia filtration systems and incur one-time costs to achieve model effluent concentrations and PNFs;
- Two sites would install blowdown filtration units to achieve model effluent concentrations; and
- Twelve sites would not incur any costs to comply with BAT-1.

The Agency estimates that six of the sites mentioned above would install multimedia filtration systems to treat flow rates below 50 gallons per minute (gpm). Based on vendor information obtained for small-scale multimedia filtration systems, the Agency estimates an investment cost of $200,000 would be required to purchase and install these systems.

PSES-1 (Carbon and Alloy Segment)

Of the seven indirect discharging carbon steel integrated and stand-alone hot forming sites, the Agency estimates that one site would incur a one-time cost to achieve the model PNF. EPA also estimates that two sites would install blowdown filtration systems to treat flow rates less than 50 gpm and incur a one-time cost to achieve model treatment concentrations and that four sites would not incur any costs to comply with PSES-1.

PSES-1 (Stainless Segment)

Of the three indirect discharging stainless sites, the Agency estimates that one site would install a high-rate recycle system to replace an existing once-through system, and that two sites would incur a one-time cost to achieve the model PNF.

9.2.5 Non-Integrated Steelmaking and Hot Forming Subcategory

The Agency estimates that 39 carbon steel mini-mills discharge wastewater from vacuum degassing, continuous casting, or hot forming operations, whether co-treated or treated separately, to surface waters of the United States and 15 discharge wastewater from these operations to POTWs. The Agency also estimates that four stainless steel mini-mills discharge wastewater from vacuum degassing, continuous casting, or hot forming operations, whether co-treated or treated separately, to surface waters of the United States and four discharge wastewater from these operations to POTWs.

The table below summarizes the technology options evaluated for the carbon and alloy and stainless segments. Agency cost estimates for these options are discussed in the subsections below and presented in Table 9-21.

Technology Options for Non-Integrated Steelmaking and Hot Forming

Treatment Unit	BAT-1	BAT-2	PSES-1
Scale pit with oil skimming (continuous casting and hot forming only)	✔	✔	✔
Clarifier	✔	✔	✔
Sludge dewatering	✔	✔	✔
Cooling tower	✔	✔	✔
Multimedia filtration[a]	✔	✔	✔
High-rate recycle	✔	✔	✔
Blowdown treatment			
Metals precipitation[a,b]		✔	
Multimedia filtration[a]	✔	✔	✔

[a]May be used in recycle circuit or as blowdown treatment.
[b]Applies to Stainless Steel Segment only.

BAT-1 (Carbon and Alloy Segment)

The Agency estimates that two sites would replace existing once-through treatment systems with high-rate recycle systems and three sites would install blowdown

multimedia filtration systems to treat flow rates below 50 gpm to achieve model treatment concentrations. EPA estimates that nine sites would install blowdown multimedia filtration systems and incur a one-time cost to achieve model treatment; of these nine sites, seven would treat flow rates below 50 gpm. The Agency believes that there are four mini-mills that would not incur any costs to comply with BAT-1. The Agency believes that 21 mini-mills would achieve model PNFs after incurring a one-time cost.

PSES-1 (Carbon and Alloy Segment)

The Agency estimates that two sites would install a blowdown multimedia filtration system to treat flow rates below 50 gpm to achieve model effluent concentrations, 10 sites would install a blowdown multimedia filtration system to treat flow rates below 50 gpm and incur a one-time flow reduction cost, and three sites would incur a one-time cost to achieve model PNFs.

BAT-1 (Stainless Segment)

The Agency estimates that two sites would incur one-time costs to achieve model PNFs, one site would install a blowdown multimedia filtration system and incur a one-time cost to achieve model effluent concentrations and PNFs, and one site would not incur any costs to comply with BAT-1.

BAT-2 (Stainless Segment)

The Agency estimated costs for metals precipitation but the demonstrated technology showed the pollutant removals were insignificant, as discussed in Section 10.

PSES-1 (Stainless Segment)

The Agency estimates that four sites would incur a one-time cost to achieve model PNFs.

9.2.6 Steel Finishing Subcategory

The Agency estimates that 51 carbon steel and 18 stainless steel finishing mills discharge wastewater to surface water in the United States and 31 carbon steel and 14 stainless steel finishing mills discharge wastewater to POTWs.

The table below summarizes the technology options evaluated for the carbon and alloy and stainless segments. The Agency evaluated PNFs from manufacturing lines at each site for comparison with model PNFs. For lines with PNFs within 25 percent of the model PNF, EPA allocated a one-time cost to sites to achieve model PNFs. The Agency assumes relatively minor costs are associated with controlling rinse water flow rates to achieve these flow reductions and would be included in the one-time cost. For manufacturing lines with PNFs greater than 25

percent, the Agency estimated costs to install countercurrent rinse tanks at $250,000 per line. This estimate is based on installation of an additional 10,000-gallon rinse tank with associated pumps and blowers for bath agitation. Also in this estimated cost, the Agency assumed lost line revenue from downtime for two days for tank installation, at an average of $448/ton of cold rolled coil sheet steel based on a median production rate of 95 tons/day for all finishing sites (Reference 9-6). Furthermore, EPA did not assign incremental operating and maintenance costs for installation of countercurrent rinse tanks. The Agency assumed that operating and maintenance costs incurred because of installation of these tanks would be minimal and offset by likely savings in rinse water usage and process water chemical treatment. The Agency will pursue further data gathering after-proposal to more accurately estimate costs associated with installation of an additional rinse tank. Agency cost estimates for the evaluated technology options are discussed in the subsections below and presented in Table 9-22.

Technology Options for Steel Finishing Subcategory

Treatment Unit	BAT-1	PSES-1
In-Process Controls		
Countercurrent rinses	✔	✔
Recycle of fume scrubber water	✔	✔
Acid purification units (stainless steel only)	✔	✔
Wastewater Treatment		
Diversion tank	✔	✔
Oil removal	✔	✔
Hydraulic and waste loading equalization	✔	✔
Hexavalent chromium reduction	✔	✔
Multiple-stage pH control for metals precipitation	✔	✔
Clarification	✔	✔
Sludge dewatering	✔	✔

BAT-1 (Carbon and Alloy Segment)

The Agency estimates that eight sites would incur a one-time flow reduction cost for a single line to achieve model PNFs. Based on industry survey responses, six sites would incur a one-time cost to optimize existing metals precipitation systems. The Agency assumed a 15 percent increase in annual operating and maintenance costs for these sites. EPA estimates that

three sites would require wastewater treatment modifications and incur a one-time cost to achieve model effluent concentrations and PNFs. One of these sites was costed to segregate hot forming and finishing wastewater that was co-treated in an end-of-pipe system. EPA distributed costs associated with this modification to the Integrated and Stand-Alone Hot Forming Subcategory and Steel Finishing Subcategory according to the relative percentage of wastewater flow reported by this site from both subcategories.

In addition to the in-process control and wastewater treatment modifications mentioned above, the Agency also estimates that:

- Six sites would install countercurrent rinse tanks on a single line;
- Thirteen sites would install countercurrent rinse tanks and incur a one-time cost to achieve model PNFs on multiple lines;
- Four sites would install countercurrent rinse tanks on multiple lines and incur a one-time cost and a 15 percent increase in annual operating and maintenance costs to optimize existing metals precipitation systems; and
- Eleven sites would not incur any cost to comply with BAT-1.

PSES-1 (Carbon and Alloy Segment)

The Agency estimates that four sites would require wastewater treatment modifications to achieve model treatment. EPA estimated costs for three of these sites to install metals precipitation systems, clarifiers, and associated sludge handling systems and for the other site was to install a clarifier.

In addition to the wastewater treatment modifications mentioned above, the Agency also estimates that:

- Six sites would incur a one-time cost to achieve model PNFs on a single line;
- Two sites would incur a 15 percent increase in annual operating and maintenance costs to optimize existing metals precipitation systems;
- Two sites would install metals precipitation systems, clarifiers, and associated sludge handling systems, install countercurrent rinse tanks, and incur a one-time cost to achieve model PNFs;
- Three sites would install a countercurrent rinse tank on a single line;

- Two sites would install a countercurrent rinse tank on a single line, incur a one-time cost to achieve model PNFs, and incur a 15 percent increase in annual operating and maintenance costs to optimize existing metals precipitation systems;

- Two sites would install countercurrent rinse tanks on multiple lines; and

- Ten sites would not incur costs to comply with PSES-1.

BAT-1 (Stainless Segment)

The Agency estimates that nine sites contract hauled or treated spent acid pickling baths. Of these nine sites, EPA assumed that seven would install a single acid purification unit and countercurrent rinse tanks on multiple lines as a result of BAT-1 model effluent concentrations and PNFs, while two would install multiple acid purification units and install countercurrent rinse tanks on multiple lines.

In addition to the in-process control modifications mentioned above, the Agency also estimates that:

- Two sites would incur a one-time cost to achieve model PNF for a single line;

- Three sites would install countercurrent rinse tanks on multiple lines and incur a one-time cost to achieve model PNFs;

- Two sites would install countercurrent rinse tanks on multiple lines and incur a one-time cost and a 15 percent increase in annual operating and maintenance costs to optimize existing metals precipitation systems; and

- Two sites would not incur a cost to comply with BAT-1.

PSES-1 (Stainless Segment)

The Agency estimates that five sites contract hauled or treated spent acid pickling baths, assuming that these sites would install acid purification units to achieve model effluent concentrations. Of these five sites, the Agency also estimates that two would incur a one-time cost and a 15 percent increase in annual operating and maintenance costs to optimize existing metals precipitation systems.

In addition to the in-process control and wastewater treatment modifications mentioned above, the Agency also estimates that:

- Two sites would incur a one-time cost and a 15 percent increase in annual operating and maintenance costs to optimize existing metals precipitation systems;

- One site would install countercurrent rinse tanks on a single line;

- One site would install countercurrent rinse tanks on multiple lines, incur a one-time cost to achieve model PNFs on multiple lines, and incur a 15 percent increase in annual operating and maintenance costs to optimize an existing metals precipitation system; and

- Five sites would not incur a cost to comply with PSES-1.

9.2.7 Other Operations Subcategory

Direct Reduced Ironmaking (DRI) Segment

The table below presents the BPT technology option evaluated for this segment. EPA is not discussing or presenting cost estimates because data aggregation or other masking techniques are insufficient to protect confidential business information. The Agency evaluated effluent total suspended solids concentrations reported by sites, PNFs, and technology in place to determine appropriate costs to achieve model treatment.

Technology Options for DRI Segment

Treatment Unit	BPT/PSES-1
Classifier	✔
Clarifier	✔
Sludge dewatering	✔
Cooling tower	✔
High-rate recycle	✔
Blowdown treatment	
Multimedia filtration	✔

Forging Segment

Of the eight direct discharging forging operations and four indirect discharging forging operations, the Agency estimates that six sites would incur a one-time cost to achieve model PNFs. EPA assigned a one-time cost of $20,000 for consultant and mill services to evaluate how to modify contact water management practices to achieve the model PNF for

forging. Forging operations at iron and steel sites are small-scale operations that range in production from 500 to 90,000 tons of steel per year. Sites estimated to incur a one-time cost forge well below 20,000 tons of steel per year. Consequently, the Agency's estimate is based on a short-term study, consisting of 150 hours of direct labor (50 hours of field work and 100 hours of office work) at a labor rate of $100 per hour. The Agency also estimates approximately $2,500 for airfare, food, lodging, and other direct costs (equipment rental, analytical costs, telephone costs) and $2,500 for miscellaneous expenses. Table 9-23 presents Agency cost estimates for the BPT option.

Technology Options for Forging Segment

Treatment Unit	BPT
High-rate recycle	✔
Blowdown treatment	
Oil/water separator	✔

9.3 References

9-1 U.S. Environmental Protection Agency. Economic Analysis of the Proposed Effluent Limitations Guidelines and Standards for the Iron and Steel Manufacturing Point Source Category. EPA 821-B-00-009, Washington, D.C., December 2000.

9-2 U.S. Department of Labor, Monthly Labor Review. Washington, D.C., 1997.

9-3 Perry, R. and Green, D. Perry's Chemical Engineer's Handbook, Sixth Edition. McGraw-Hill, Inc., 1984.

9-4 Chemical Market Reporter. Schnell Publishing Company, December 1997.

9-5 U.S. Department of Energy. Electric Power Annual 1998. Volume I. Washington, D.C., 1998.

9-6 U.S. Department of Commerce. Current Industrial Reports, Steel Mill Products - 1997. MA33B, September 1998.

Table 9-1

Cost Factors to Determine Investment Costs

Category	Item	Cost Factor (% of equipment cost)
Direct costs[a]	Equipment cost	100
	Freight	3
	Installation labor	40
	Site preparation	15
	Equipment foundations and structural support	40
	Buildings	15
	Piping	35
	Electrical and process control	30
	Subtotal	278
Indirect costs	Temporary facilities (1%)[b]	3
	Spare parts (1.5%)[b]	4
	Engineering procurement and contract management (12%)[b]	34
	Commissioning and start-up (3%)[b]	8
	Owner team (10%)[b]	28
	Subtotal (27.5% of subtotal of direct costs)	77
Total project cost		**355**

[a]Direct cost factors include contingency costs.
[b]Percentage of subtotal of direct costs; standard factors used by engineering and design firm.

Table 9-2

Iron and Steel Investment Cost Equations

Equipment	Investment Cost Equation	Applicable Subcategory	Range of Validity	Source(s)
Biological nitrification (chemicals include caustic, phosphoric acid, polymer, and defoaming agent)	($): 22,013 × flow (gpm)	Cokemaking	50 to 500 gpm	Capital cost survey, vendor information
Flow equalization tank (prior to ammonia stripping and biological nitrification)	($): (1-day HRT) × flow (gpm) × 1440 min/day = V If V is ≤ 250,000, then investment ($) = $1.09/gal × 250,000 gal ≤ 500,000, then investment ($) = $1.09/gal × 500,000 gal ≤ 750,000, then investment ($) = $1.09/gal × 750,000 gal ≤ 1,000,000, then investment ($) = $1.09/gal × 1,000,000 gal ≤ 1,250,000, then investment ($) = $1.09/gal × 1,250,000 gal	Cokemaking	250,000 to 1,250,000 gallons	Capital cost survey, vendor information
Clarification of activated sludge	($): 782.4 × flow rate (gpm) @ 600 gal/day/ft^2	Cokemaking	20 to 90 ft diameter	Capital cost survey, vendor information
Heat exchanger	($): 933 × flow rate (gpm)	Cokemaking	20 to 300 gpm of hot water flow influent temp: 140°F effluent temp: 80°F	Capital cost survey, vendor information

Table 9-2 (Continued)

Equipment	Investment Cost Equation	Applicable Subcategory	Range of Validity	Source(s)
Sludge thickening of activated sludge and metal hydroxides	($): 168.3 × flow (gpm) + 213,320 where flow is through thickener (activated sludge) ($): 1,581.5 × flow (gpm) + 144,799 where flow is assumed to be 4% of flow to the clarifier (metal hydroxides)	Cokemaking Ironmaking Steel Finishing	0.5 to 1,390 gpm	Capital cost survey, vendor information
Belt filter press	($): 813 × wastewater flow (gpm) where flow is flow through biological nitrification	Cokemaking	4 to 14 tons/day of wet sludge	Capital cost survey, vendor information
Cyanide precipitation (chemicals include ferric sulfate, sulfuric acid, polymer, and sodium hydroxide)	($) 762.36 × flow (gpm) + 113,338 Sulfuric acid feed system: 88.816 × flow (gpm) + 35,692 Ferric sulfate feed system: 79.059 × flow (gpm) + 23,332 Polymer feed system: 68.132 × flow (gpm) + 12,061 Sodium hydroxide feed system: 14.306 × flow (gpm) + 35,927	Cokemaking	40 to 400 gpm	Capital cost survey, vendor information
Alkaline chlorination of cokemaking wastewater	($): 3,165 × flow (gpm) + 1,000,000 [hatch, includes feed systems]	Cokemaking	88 to 2,340 gpm	Engineering and design firm
Sludge thickening for iron-cyanide sludge	($): 63,261 × flow (gpm) + 144,799	Cokemaking	40 to 400 gpm	Capital cost survey, vendor information
Plate and frame filter press	($): 117.6 × flow (gpm) + 47,553 (Cokemaking) ($): 1,340.8 × flow (gpm) + 47,553 (Steel Finishing)	Cokemaking Steel Finishing	104 to 1,390 gpm	Capital cost survey, vendor information
Multimedia filtration	($): 454.38 × flow (gpm) + 895,589 92.55 × flow (gpm) + 3,000,000	Cokemaking Ironmaking Integrated Steelmaking Integrated and Stand-Alone Hot Forming Non-Integrated Steelmaking and Hot Forming Other Operations	50 to >5,200 gpm	Engineering and design firm

Table 9-2 (Continued)

Equipment	Investment Cost Equation	Applicable Subcategory	Range of Validity	Source(s)
Granular activated carbon	($): 950.31 × flow (gpm) + 848,478	Cokemaking	88 to 2,340 gpm	Engineering and design firm
Chemical precipitation	($): 1,344.4 × flow (gpm) + 1,000,000 (Ironmaking) ($): 1,324.8 × flow (gpm) + 842,049 (Integrated Steelmaking) ($): 748.02 × flow (gpm) + 162,686 (Steel Finishing)	Ironmaking Integrated Steelmaking Steel Finishing	104 to 1,390 gpm	Capital cost survey, vendor information
Alkaline chlorination of blast furnace and sintering wastewater	($): 1,344.4 × flow (gpm) + 811,989	Ironmaking	104 to 1,390 gpm	Engineering and design firm
Vacuum filtration	($): 1.13 × (sludge generation (lbs/day)) + 151,037 where sludge generation is 26 lbs/day/gpm	Ironmaking	104 to 1,390 gpm	Capital cost survey, vendor information
Roughing clarifier	($): 86.4 × flow (gpm)	Integrated and Stand-Alone Hot Forming Non-Integrated Steelmaking and Hot Forming	5,000 to 15,000 gpm	Capital cost survey, vendor information
Cooling tower	($): 32.17 × flow (gpm) + 234,335	Integrated and Stand-Alone Hot Forming Non-Integrated Steelmaking and Hot Forming	500 to 60,000 gpm	Capital cost survey, vendor information
Recycle pump station	($): 10.529 × flow (gpm) + 56,925	Integrated and Stand-Alone Hot Forming Non-Integrated Steelmaking and Hot Forming	6,900 to 35,000 gpm	Capital cost survey, vendor information
Acid purification unit	($): 500,000	Steel Finishing	9 gpm	Vendor information

Table 9-2 (Continued)

Equipment	Investment Cost Equation	Applicable Subcategory	Range of Validity	Source(s)
Lime feed system	($): 50,591 × flow (gpm) + 27,665	Steel Finishing	104 to 1,390 gpm	Vendor information
Inclined plate clarification	($): 508.3 × flow (gpm) + 33,538	Steel Finishing	50 to 400 gpm	Capital cost survey, vendor information

Variable Definitions

HPD - 24 hours of operation per day.
DPY - 365 days of operation per year.
FT3 - Daily cake volume from all presses.
Lbs/day - Pounds per day.

Table 9-3

Iron and Steel Operating and Maintenance (O&M) Cost Equations

Equipment	Cost Equation	Applicable Subcategory	Range of Validity
Biological nitrification (chemicals include caustic, phosphoric acid, polymer, and defoaming agent)	Electrical ($/yr): 810 × flow (gpm) Chemicals ($/yr): 639 × flow (gpm) O&M labor ($/yr): 8,760 hrs/yr × $29.67/hr = $260,000 Maintenance equipment and vendors ($/yr): 0.06 × (5,711 × flow (gpm)) Monitoring ($/yr): $60,000 Sludge disposal ($/yr): cost included with belt filter O&M	Cokemaking	50 to 500 gpm

Table 9-3 (Continued)

Equipment	Cost Equation	Applicable Subcategory	Range of Validity
Flow Equalization Tank (prior to ammonia stripping and biological nitrification)	Electrical (before ammonia stripper) ($/yr): (0.092 HP/gpm × flow (gpm)) × 0.7456 kW/HP × 8,760 hrs/yr × 0.047/kWh where flow is ammonia still flow Electrical (before biological nitrification) ($/yr): 0.092 HP/gpm × flow (gpm) × 0.7456 kW/HP × 8,760 hrs/yr × $0.047/kWh where flow is biological treatment flow Chemicals ($/yr): 0 O&M labor (before ammonia stripper and biological nitrification) ($/yr): 1.5 hrs/day × 365 days/yr × $29.67/hr = 16,250 Maintenance equipment and vendors (before ammonia stripper) ($/yr): flow (gpm)/100 gpm × $5,534 where flow is ammonia still flow Maintenance equipment and vendors (before biological nitrification) ($/yr): flow (gpm)/100 gpm × $5,534 where flow is biological treatment flow	Cokemaking	250,000 to 1,250,000 gallons
Clarification of activated sludge	Electrical, chemical, O&M labor, maintenance equipment, and vendor costs included with biological nitrification O&M	Cokemaking	20 to 90 ft diameter

Table 9-3 (Continued)

Equipment	Cost Equation	Applicable Subcategory	Range of Validity
Heat exchanger	Electrical ($/yr): (0.0746 × wastewater flow (gpm)) kWh × 8,760 hrs/yr × $0.047/kWh O&M labor ($/yr): 1 hr/wk × 52 wk/yr × $29.67/hr = 1,540 Maintenance equipment and vendors ($/yr): (933 × flow (gpm)) × 0.06	Cokemaking	20 to 300 gpm of hot water flow Influent temp:140°F Effluent temp: 80°F
Sludge thickening of activated sludge and metal hydroxides	Electrical ($/yr): (Flow (gpm)/35 × 5) × 0.7456 kW/HP × 8,760 hrs/yr × $0.047/kWh where flow is 4% of flow to the clarifier Chemicals ($/yr): (cost included with biological nitrification, chemical precipitation, and clarification) O&M labor ($/yr): DPY/2 × 1 hour × $29.67/hr = $5,420 Maintenance equipment and vendors ($/yr): 0.06 × investment cost Sludge disposal ($/yr): (applies to Cokemaking Subcategory only, cost included with belt filter O&M)	Cokemaking Ironmaking Steel Finishing	0.5 to 1,390 gpm
Belt filter press	Electrical, chemical, O&M labor, maintenance equipment, and vendor costs included with biological nitrification O&M Sludge disposal ($/yr): Flow (gpm) × 24 lbs/day/gpm × 365 days/yr × $0.0025/lb	Cokemaking	4 to 14 tons/day of wet sludge

Table 9-3 (Continued)

Equipment	Cost Equation	Applicable Subcategory	Range of Validity
Cyanide precipitation (chemicals include ferric sulfate, sulfuric acid, polymer, and sodium hydroxide)	Electrical ($/yr): 6.67 × flow (gpm) Chemicals ($/yr): 989.75 × flow (gpm) (all chemicals) O&M labor ($/yr): 1,343.6 × flow (gpm) Maintenance equipment and vendors ($/yr): 250 × flow (gpm) Monitoring ($/yr): 2,000 Sludge disposal ($/yr): 16.4 × flow (gpm)	Cokemaking	40 to 400 gpm
Sludge thickening for iron-cyanide sludge	All O&M costs are included with cyanide precipitation	Cokemaking	40 to 400 gpm
Plate and frame filter press	Electrical ($/yr): 0 Chemicals ($/yr): (costs are included in chemical feed systems) O&M labor ($/yr): $29.67 x 3 hrs/day x DPY	Cokemaking	40 to 400 gpm
Polymer feed system	All O&M costs are included where polymer is used.	Cokemaking Ironmaking Integrated Steelmaking Steel Finishing	40 to 1,390 gpm
Ferric sulfate feed system	All O&M costs are included with cyanide precipitation.	Cokemaking	40 to 400 gpm
Sodium hydroxide feed system	All O&M costs are included where sodium hydroxide is used.	Cokemaking Ironmaking Integrated Steelmaking	40 to 400 gpm

Table 9-3 (Continued)

Equipment	Cost Equation	Applicable Subcategory	Range of Validity
Sulfuric acid feed system	Electrical ($/yr): [0.005 × flow (gpm) + 0.0261] kW × 1,440 min/day × DPY × $0.047/kWh Chemicals ($/yr): (chemical costs included where sulfuric acid is used) O&M labor ($/yr): HPD/8 × DPY × $29.67/hr Maintenance equipment and vendors ($/yr): 0.06 × (88.816 × flow (gpm) + 35,692)	Cokemaking Ironmaking	40 to 400 gpm
Alkaline chlorination	Electrical ($/yr): 90.6 × flow (gpm) Chemicals ($/yr): — Sodium hypochlorite: 6.43 × flow (gpm) × (mg/L CN × 8.5 + mg/L NH4 × 7.4) — Sodium hydroxide: 1.58 × flow (gpm) — Sulfuric acid: 83.6 × flow (gpm) — Sodium bisulfite: 1.82 × flow (gpm) × (mg/L CN × 1.7 + mg/L NH4 × 1.5) O&M labor ($/yr): 1 hr/shift × 3 shifts/day × DPY × $29.67/hr = 32,500 Maintenance equipment and vendors ($/yr): 250 × flow (gpm) Monitoring ($/yr): 2,000	Cokemaking	88 to 2,340 gpm

Table 9-3 (Continued)

Equipment	Cost Equation	Applicable Subcategory	Range of Validity
Multimedia filtration	Electrical ($/yr): [(0.0504 × (flow rate in gpm)) + 1.0139] × 8,760 hrs/yr × $0.047/kWh Chemicals ($/yr): 0 O&M Labor ($/yr): 1.5 hrs/day × 365 days/yr × $29.67/hr = 16,240 Maintenance equipment and vendors ($/yr): 0.06 × investment cost Monitoring ($/yr): NA	Cokemaking Ironmaking Integrated Steelmaking Integrated and Stand-Alone Hot Forming Non-integrated Steelmaking and Hot Forming Other Operations	< 50 gpm to >5,200 gpm
Granular activated carbon	Electrical ($/yr): 9.6 × flow (gpm) Chemicals ($/yr): NA O&M labor ($/yr): 8.13 × flow (gpm) Maintenance equipment and vendors ($/yr): 1228.6 × flow (gpm) Monitoring ($/yr): 60 × flow (gpm)	Cokemaking	88 to 2,340 gpm

Table 9-3 (Continued)

Equipment	Cost Equation	Applicable Subcategory	Range of Validity
Chemical precipitation	Electrical ($/yr): [(0.0934 × flow (gpm)) + 0.7763]HP × 0.7456 kW/HP × DPY × HPD × $0.047/kWh Chemicals ($/yr): — Lime flow (gpm) × 1,440 mm/day × 0.0004 lbs/gal × DPY × $0.035/lb (Steel Finishing) — NaOH flow (gpm) × 1,440 min/day × 0.0033 lbs/gal × DPY × $0.15/lb (Ironmaking, Integrated Steelmaking) — Polymer flow (gpm) × 1,440 min/day × 0.00005 lbs/gal × DPY × $0.20/lb (Ironmaking, Integrated Steelmaking) flow (gpm) × 1,440 min/day × 0.000018 lbs/gal × DPY × $0.20/lb (Steel Finishing) O&M labor ($/yr): 3 shifts/day × 4 hrs/shift × DPY × $29.67/hr Maintenance equipment and vendors ($/yr): 0.06 × investment cost Monitoring ($/yr): NA	Ironmaking Integrated Steelmaking Steel Finishing	104 to 1,390 gpm

Table 9-3 (Continued)

Equipment	Cost Equation	Applicable Subcategory	Range of Validity
Alkaline chlorination of blast furnace and sintering wastewater	Electrical ($/yr): 79.8 × flow (gpm) Chemicals ($/yr): — Sodium hypochlorite 0.0027 lbs/gal × flow (gal/min) × 1,440 min/day × 365 days/year × 1.47 $/lb — Sulfuric acid 0.0006 lbs/gal × (flow rate (gpm)) × 1,440 min/day × 365 days/yr × 0.043 $/lb — Sodium bisulfite (0.00054 lbs/gal) × flow (gpm) × 1440 min/day × 365 days/yr × (104 g/mol $NaHSO_3$/ 81 g/mol HSO_3) × $0.325/lb O&M labor ($/yr): 1 hr/shift × 3 shifts/day × DPY × $29.67/hr = $32,000 Maintenance Equipment and Vendors ($/yr): 0.06 × (2,733.2 × flow (gpm) + 811,989) Monitoring ($/yr): 2,000	Ironmaking	104 to 1,390 gpm

Table 9-3 (Continued)

Equipment	Cost Equation	Applicable Subcategory	Range of Validity
Vacuum filtration	Electrical ($/yr): [(0.0002 × (sludge generation (lbs/day)) + 3.491]kW × DPY × HPD × $0.047/kWh Chemicals ($/yr): 156 lbs/day × DPY × $0.21/lb (diatomaceous earth) O&M labor ($/yr): DPY × 3 shifts/day × 4 hr/shift × $29.67/hr Maintenance equipment and vendors ($/yr): 0.06 × investment cost Monitoring ($/yr): 0	Ironmaking	104 to 1,390 gpm
Roughing clarifier	Electrical ($/yr): 0 Chemicals ($/yr): 0 O&M labor ($/yr): DPY/2 × 1hr × $29.67/hr = $5,420 Maintenance equipment and vendors ($/yr): 0.06 × investment cost Monitoring ($/yr): NA	Integrated and Stand-Alone Hot Forming Non-Integrated Steelmaking and Hot Forming	5,000 to 15,000 gpm

Table 9-3 (Continued)

Equipment	Cost Equation	Applicable Subcategory	Range of Validity
Cooling tower	Electrical ($/yr): [((0.035 × flow rate (gpm))/3.5 gpm/ft) + ((flow (gpm) × 40 feet)/(3,960 × 0.75))] × 0.7456kW/HP × DPY × HPD × $0.047/kWh Chemicals ($/yr): — Biocide: $4.00 × cooling tower flow (gpm) × 10 minutes/1,000 × DPY/2 — Scale inhibitor: 0.02 lbs/day/gpm × cooling tower flow (gpm) × DPY × $0.19/lb O&M labor ($/yr): ((1.5 hrs/day × DPY × $29.67/hr) + (4 persons × 40 hrs/person × $29.67/hr)) = $21,000 Maintenance equipment and vendors ($/yr): 0.06 × (32.17 × flow (gpm) +234,335) Monitoring ($/yr): 0	Integrated and Stand-Alone Hot Forming Non-Integrated Steelmaking and Hot Forming	500 to 60,000 gpm

Table 9-3 (Continued)

Equipment	Cost Equation	Applicable Subcategory	Range of Validity
Recycle pump station	Electrical ($/yr): (0.0193 × flow (gpm) + 90.527)HP × 0.7456 kW/HP × HPD × DPY × $0.047/kWh Chemicals ($/yr): 0 O&M labor ($/yr): 40 hrs/yr × $29.67/hr Maintenance equipment and vendors ($/yr): 0.06 × (10,529 × flow (gpm) + 56,925) Monitoring ($/yr): 0	Integrated and Stand-Alone Hot Forming Non-Integrated Steelmaking and Hot Forming	6,900 to 35,000 gpm
Acid purification unit	Electrical ($/yr): 5 HP × 0.7456kW/HP × HPD × DPY × $0.047/kWh = $1,540 Chemical cost savings ($/yr): $0.47/ton of steel finished per year O&M labor ($/yr): ((0.5 hrs/day × DPY)+(3hrs/wk × DPY/7)) × $29.67/hr Maintenance equipment and vendors ($/yr): 0.06 × ((500,000) + (0.075 × 500,000/5yrs)) = $10,100 Monitoring ($/yr): (0.075 × investment)/5 = $7,500 Waste disposal savings (if site contract hauls waste ($/yr): $0.67/ton steel finished per year	Steel Finishing	9 gpm

Table 9-3 (Continued)

Equipment	Cost Equation	Applicable Subcategory	Range of Validity
Lime feed system	All O&M costs are included in chemical precipitation	Steel Finishing	104 to 1,390 gpm
Inclined plate clarification	Electrical ($/yr): 0 Chemicals ($/yr): 0 O&M labor ($/yr): DPY/2 × 1 hr × $29.67/hr Maintenance equipment and vendors ($/yr): 0.06 × (508.3 × flow (gpm) + 33,538) Monitoring ($/yr): 0	Steel Finishing	50 to 400 gpm

Variable Definitions:

HPD - 24 hours of operation per day.
DPY - 365 days of operation per year.
FT3 - Daily cake volume from all presses.
lbs/day - Pounds per day.

Table 9-4

Assumptions Used to Estimate Investment Costs

Category	Assumption
Spatial limitations	Additions to the wastewater treatment system will be located within 500 feet of the existing system.
	An approximate length of 500 feet is used for the supply of water to the new water treatment facility.
	Equipment is located so that the length between processing tanks, sumps, and processing equipment will be within 20 feet.
	Outfalls or sewers leading to outfalls are located within 100 feet of the exit of the new water treatment facility.
	Motors are located within 150 feet from motor control center, 160 feet of conduit per motor, 260 feet of control cable per motor.
Solids handling	Sludge or filter backwash generated from add-on treatment systems will be thickened and dewatered with existing equipment in existing high-rate recycle systems, except for blast furnace operations, where separate sludge dewatering facilities were costed for blowdown treatment systems to segregate high zinc-content sludges from wastewater sludges that may be recycled to the blast furnaces.
Civil/structural costs	Site preparation is minimal; no major demolition, excavation of existing foundations or movement of railroad tracks.
	Soil conditions are such that no piles are required.
	No excavation of hazardous materials.
Piping/installation	1,000 feet of 2-inch carbon steel pipe has been included for plant air distribution. There is no allowance for an air compressor.
	Pipe has been sized to keep the water velocity less than 8 feet per second.
	2-inch nominal piping and under is priced as schedule 80 threaded carbon steel.
	Pipe over 2 inches is priced as standard schedule carbon steel pipe with welded joints.
	316 stainless steel pipe is used for chlorine, caustic, and acid piping.
	Costs for supports and painting are included.
	Insulation costs are not included.
	10% of the total cost allowed for manual valves.
Electrical/process control instrumentation	5% of the total cost allowed for instrumentation.
	Electrical and other utility services are available at the site.

Table 9-5

Design Specifications for Cokemaking Granular Activated Carbon Treatment Systems

Item	Type	100,000 gpd		400,000 gpd		2,700,000 gpd	
		Number	Size	Number	Size	Number	Size
Pump station 1	Vertical turbine	2 pumps	1.5 HP	2 pumps	7.5 HP	2 pumps	40 HP
Pump station 2	Vertical turbine	2 pumps	1/3 HP	2 pumps	1/3 HP	2 pumps	2 HP
Filter backwash pump	Vertical turbine	2 pumps	5 HP	2 pumps	5 HP	2 pumps	2 BHP
Equalization basin	Concrete	1	3,500 ft^3	1	13,500 ft^3	1	90,000 ft^3
Sump 1	Concrete	1	450 ft^3	1	700 ft^3	1	4,000 ft^3
Backwash surge basin	Concrete	1	450 ft^3	1	700 ft^3	1	4,000 ft^3
Activated carbon system	Filters	2	4' × 3'/ 7.5 HP	2	7' × 7'/ 7.5 HP	3	15' × 10/ 20 HP

Table 9-6

Estimated Investment Costs for Cokemaking Granular Activated Carbon Systems (100,000 - 2,700,000 gpd)

100,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Activated carbon system	2	$80,000	$160,000
	Activated carbon	1	$5,000	$5,000
	Pump station 1	2	$1,100	$2,200
	Pump station 2	2	$2,500	$5,000
	Filter backwash pumps	2	$3,000	$6,000
	Total freight			**$5,300**
	Subtotal			**$183,500**
Installation	**Mechanical equipment installation**			
	Activated carbon system	2	$11,000	$22,000
	Pump station 1	2	$1,500	$3,000
	Pump station 2	2	$1,500	$3,000
	Filter backwash pumps	2	$2,000	$4,000
	Piping installation			
	Piping/supports	1	$58,000	$58,000
	Control valves/instrumentation	1	$10,200	$10,200
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	Activated carbon system	1	$27,400	$27,400
	Equalization basin	1	$66,600	$66,600
	Sump 1	1	$19,000	$19,000
	Backwash surge basin	1	$19,000	$19,000

Table 9-6 (Continued)

100,000 gpd				
Installation (cont.)	**Equipment structural support**			
	Pump station 1 platform	1	$4,000	$4,000
	Pump station 2 platform	1	$2,000	$2,000
	Filter backwash pumps	1	$8,000	$8,000
	Buildings			
	Activated carbon system	1	$21,000	$21,000
	Electrical and process control			
	Power/equipment	1	$48,100	$48,100
	Control/instrumentation	1	$40,600	$40,600
	Building services	1	$4,400	$4,400
	Subtotal			**$360,300**
Indirect costs	Temporary facilities (1%)			$5,400
	Spare parts (1.5%)			$8,200
	Engineering procurement and contract management (12%)			$65,300
	Commissioning (3%)			$16,300
	Owner team (10%)			$54,400
	Subtotal			**$149,600**
Total costs	Total direct and indirect costs			$693,400
	Contingency (20%)			$138,700
	Total Project Cost			**$832,100**

400,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Activated carbon system	2	$90,000	$180,000
	Activated carbon	1	$15,000	$15,000
	Pump station 1	2	$6,400	$12,800
	Pump station 2	2	$1,100	$2,200
	Filter backwash pumps	2	$6,500	$13,000
	Total freight			$6,700
	Subtotal			**$229,700**

Table 9-6 (Continued)

400,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation	Mechanical equipment installation			
	Activated carbon system	2	$12,000	$24,000
	Pump station 1	2	$2,000	$4,000
	Pump station 2	2	$1,500	$3,000
	Filter backwash pumps	2	$2,000	$4,000
	Piping installation			
	Piping/supports	1	$91,100	$91,100
	Control valves/instrumentation	1	$16,100	$16,100
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	Activated carbon system	1	$35,000	$35,000
	Equalization basin	1	$152,300	$152,300
	Sump 1	1	$22,000	$22,000
	Backwash surge basin	1	$22,000	$22,000
	Equipment structural support			
	Pump station 1 platform	1	$8,000	$8,000
	Pump station 2 platform	1	$2,000	$2,000
	Filter backwash pumps	1	$8,000	$8,000
	Buildings			
	Activated carbon system	1	$28,000	$28,000
	Electrical and process control			
	Power/equipment	1	$48,100	$48,100
	Control/instrumentation	1	$40,600	$40,600
	Building services	1	$5,800	$5,800
	Subtotal			**$514,000**
Indirect costs	Temporary facilities (1%)			$7,400
	Spare parts (1.5%)			$11,200
	Engineering procurement and contract management (12%)			$89,200
	Commissioning (3%)			$22,300
	Owner team (10%)			$74,400
	Subtotal			**$204,500**

Table 9-6 (Continued)

400,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Total costs	Total direct and indirect costs			$948,200
	Contingency (20%)			$189,600
	Total Project Cost			**$1,137,800**

2,700,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Activated carbon system	3	$86,000	$258,000
	Activated carbon	1	$100,000	$100,000
	Pump station 1	2	$10,600	$21,200
	Pump station 2	2	$3,000	$6,000
	Filter backwash pumps	2	$1,500	$3,000
	Total freight			$11,600
	Subtotal			**$399,800**
Installation	**Mechanical equipment installation**			
	Activated carbon system	3	$12,000	$36,000
	Pump station 1	2	$2,500	$5,000
	Pump station 2	2	$2,000	$4,000
	Filter backwash pumps	2	$1,500	$3,000
	Piping installation			
	Piping/supports	1	$175,400	$175,400
	Control valves/instrumentation	1	$31,000	$31,000
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	Activated carbon system	1	$60,100	$60,100
	Equalization basin	1	$657,400	$657,400
	Sump 1	1	$59,100	$59,100
	Backwash surge basin	1	$59,100	$59,100
	Equipment structural support			
	Pump station 1 platform	1	$12,000	$12,000
	Pump station 2 platform	1	$12,000	$12,000
	Filter backwash pumps	1	$4,000	$4,000
	Buildings			
	Activated carbon system	1	$54,000	$54,000

Table 9-6 (Continued)

2,700,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Electrical and process control**			
	Power/equipment	1	$82,500	$82,500
	Control/instrumentation	1	$44,400	$44,400
	Building services	1	$11,300	$11,300
	Subtotal			**$1,310,300**
Indirect costs	Temporary facilities (1%)			$17,100
	Spare parts (1.5%)			$25,700
	Engineering procurement and contract management (12%)			$205,200
	Commissioning (3%)			$51,300
	Owner team (10%)			$171,000
	Subtotal			**$470,300**
Total costs	Total direct and indirect costs			$2,180,400
	Contingency (20%)			$436,100
	Total Project Cost			**$2,616,500**

Table 9-7

Design Specifications for Cokemaking Alkaline Chlorination Treatment Systems

Item	Type	100,000 gpd		400,000 gpd		2,700,000 gpd	
		Number	Size	Number	Size	Number	Size
Pump station 1	Vertical turbine	2 pumps	1/2 HP	2 pumps	1.5 HP	2 pumps	10 HP
Pump station 2	Vertical turbine	2 pumps	1/2 HP	2 pumps	3 HP	2 pumps	15 BHP
Pump station 3	Vertical turbine	2 pumps	1/2 HP	2 pumps	2 HP	2 pumps	15 HP
Pump station 4	Vertical turbine	2 pumps	1/2 HP	2 pumps	2 HP	2 pumps	15 HP
Pump station 5	Vertical turbine	2 pumps	1.5 HP	2 pumps	5 HP	2 pumps	30 BHP
pH adjust pump	Diaphragm	2	3 HP	2	3 HP	2	3 HP
Clarifier pump	Progressive capacity	2	3 HP	2	3 HP	2	5 BHP
NaOH pump 1	Diaphragm/ANSI	2	2 HP (diaphragm)	2	2 HP (ANSI)	2	2 HP (ANSI)
NaOH pump 2	Diaphragm	2	3 HP	2	3 HP	2	3 HP
Equalization basin	Concrete	1	4,000 ft^3	1	4,000 ft^3	1	90,000 ft^3
Reactor clarifier	Mild steel	1	12' diameter × 12' side	1	22 ft diameter × 12 ft side	1	60' diam.
Chlorination mixing tank	Concrete/lined	1	10 ft × 10 ft × 5 ft/ 5 HP	1	20 ft × 10 ft × 10 ft/ 15 HP	2	25 ft × 20 ft × 13 ft/2 @ 20 HP
Chlorination system	Building	1	10 ft × 9 ft × 20 ft/ 3 HP	1	10 ft × 9 ft × 20 ft/ 3 HP	1	15 ft × 20 ft × 20 ft/ 2 @ 3 HP
Retention tank	Concrete/lined	1	50 ft × 10 ft × 10 ft	1	50 ft × 20 ft × 20 ft	1	100 ft × 50 ft × 25 ft
Dechlorination tank	Concrete/lined	1	10 ft × 10 ft × 5 ft/ 5 HP	1	20 ft × 10 ft × 10 ft/ 15 HP	2	25 ft × 20 ft × 13 ft/ 2 @ 20 HP
Dechlorination system	Building/tank pad	1	8 ft × 8 ft × 15 ft/ 10 ft × 10 ft	1	8 ft × 8 ft × 15 ft/ 10 ft × 10 ft	1	8 ft × 8 ft × 15 ft/ 10 ft × 10 ft
NaOH tank 1	Carbon steel	2	10 ft diameter × 10 ft side	2	10 ft diameter × 10 ft side	2	10' diameter × 10' side

FRP - Fiberglass, reinforced plastic.
ANSI - American National Standards Institute.

Table 9-8

Estimated Investment Costs for Cokemaking Alkaline Chlorination Treatment Systems (100,000 - 2,700,000 gpd)

100,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Reactor clarifier	1	$40,000	$40,000
	Chlorination/dechlorination mixing systems	1	$33,300	$33,200
	NaOH tanks	2	$10,000	$20,000
	Pump station 1	2	$1,000	$2,000
	Pump station 2	2	$1,000	$2,000
	Pump station 3	2	$1,000	$2,000
	Pump station 4	2	$1,000	$2,000
	Pump station 5	2	$1,100	$2,200
	pH adjust pumps	2	$2,200	$4,400
	Clarifier pumps	2	$3,500	$7,000
	NaOH pumps 1	2	$3,500	$7,000
	NaOH pumps 2	2	$2,200	$4,400
	Total freight			**$3,800**
	Subtotal			**$130,000**
Installation	**Mechanical equipment installation**			
	Reactor clarifier	1	$100,000	$100,000
	Chlorination/dechlorination mixing systems	1	$10,000	$10,000
	NaOH tanks	2	$1,000	$2,000
	Pump station 1	2	$1,500	$3,000
	Pump station 2	2	$1,500	$3,000
	Pump station 3	2	$1,500	$3,000
	Pump station 4	2	$1,500	$3,000
	Pump station 5	2	$1,500	$3,000
	pH adjust pumps	2	$2,000	$4,000
	Clarifier pumps	2	$2,000	$4,000
	NaOH pumps 1	2	$2,000	$4,000
	NaOH pumps 2	2	$2,000	$4,000

Table 9-8 (Continued)

100,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Piping installation**			
	Piping/supports	1	$65,500	$65,500
	Control valves/instrumentation	1	$11,600	$11,600
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	Reactor clarifier/ clarifier pumps	1	$8,800	$8,800
	NaOH pumps	2	$3,500	$7,000
	NaOH tanks	1	$4,200	$4,200
	Chlorination mixing tank	1	$20,500	$20,500
	Chlorination system	1	$12,600	$12,600
	Retention tank	1	$110,800	$110,800
	Dechlorination mixing tank	1	$20,500	$20,500
	Dechlorination system	1	$12,500	$12,500
	pH adjust pumps	1	$3,500	$3,500
	Equalization basin	1	$59,100	$59,100
	Equipment structural support			
	Pump station 1 platform	1	$4,000	$4,000
	Pump station 2 platform	1	$4,000	$4,000
	Pump station 3 platform	1	$4,000	$4,000
	Pump station 4 platform	1	$4,000	$4,000
	Pump station 5 platform	1	$4,000	$4,000
	Buildings			
	Chlorination system	1	$2,000	$2,000
	Dechlorination system	1	$2,000	$2,000
	Electrical and process control			
	Power/equipment	1	$99,400	$99,400
	Control/instrumentation	1	$90,300	$90,300
	Building Services	1	$600	$600
	Subtotal			**$693,900**

Table 9-8 (Continued)

100,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Indirect costs	Temporary facilities (1%)			$8,200
	Spare parts (1.5%)			$12,400
	Engineering procurement and contract management (12%)			$98,900
	Commissioning (3%)			$24,700
	Owner team (10%)			$82,400
	Subtotal			**$226,600**
Total costs	Total direct and indirect costs			$1,050,500
	Contingency (20%)			$210,100
	Total Project Cost			**$1,260,600**

400,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Reactor clarifier	1	$52,000	$52,000
	Chlorination/dechlorination mixing systems	1	$118,800	$118,800
	NaOH tanks	2	$10,000	$20,000
	Pump station 1	2	$5,000	$10,000
	Pump station 2	2	$5,000	$10,000
	Pump station 3	2	$5,000	$10,000
	Pump station 4	2	$5,000	$10,000
	Pump station 5	2	$5,100	$10,200
	pH adjust pumps	2	$2,200	$4,400
	Clarifier pumps	2	$3,500	$7,000
	NaOH pumps 1	2	$5,000	$10,000
	NaOH pumps 2	2	$2,200	$4,400
	Total freight			**$8,000**
	Subtotal			**$274,800**

Table 9-8 (Continued)

400,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation	**Mechanical equipment installation**			
	Reactor clarifier	1	$105,000	$105,000
	Chlorination/dechlorination mixing systems	1	$35,600	$35,600
	NaOH tanks	2	$1,000	$2,000
	Pump station 1	2	$2,000	$4,000
	Pump station 2	2	$2,000	$4,000
	Pump station 3	2	$2,000	$4,000
	Pump station 4	2	$2,000	$4,000
	Pump station 5	2	$2,000	$4,000
	pH adjust pumps	2	$2,000	$4,000
	Clarifier pumps	2	$2,000	$4,000
	NaOH pumps 1	2	$1,500	$3,000
	NaOH pumps 2	2	$2,000	$4,000
	Piping installation			
	Piping/supports	1	$106,900	$106,900
	Control valves/instrumentation	1	$18,900	$18,900
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	Reactor clarifier/clarifier pumps	1	$19,300	$19,300
	NaOH pumps	2	$3,500	$7,000
	NaOH tanks	1	$4,200	$4,200
	Chlorination mixing tank	1	$41,000	$41,000
	Chlorination system	1	$12,900	$12,900
	Retention tank	1	$221,600	$221,600
	Dechlorination mixing tank	1	$41,000	$41,000
	Dechlorination system	1	$12,900	$12,900
	pH adjust pumps	1	$3,500	$3,500
	Equalization basin	1	$59,200	$59,200

Table 9-8 (Continued)

400,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Equipment structural support**			
	Pump station 1 platform	1	$6,000	$6,000
	Pump station 2 platform	1	$8,000	$8,000
	Pump station 3 platform	1	$6,000	$6,000
	Pump station 4 platform	1	$6,000	$6,000
	Pump station 5 platform	1	$12,000	$12,000
	Buildings			
	Chlorination system	1	$2,000	$2,000
	Dechlorination system	1	$2,000	$2,000
	Electrical and process control			
	Power/equipment	1	$99,500	$99,500
	Control/instrumentation	1	$90,300	$90,300
	Building services	1	$600	$600
	Subtotal			**$958,300**
Indirect costs	Temporary facilities (1%)			$12,300
	Spare parts (1.5%)			$18,500
	Engineering procurement and contract management (12%)			$148,000
	Commissioning (3%)			$37,000
	Owner team (10%)			$123,300
	Subtotal			**$339,100**
Total costs	Total direct and indirect costs			$1,572,200
	Contingency (20%)			$314,400
	Total Project Cost			**$1,886,600**

Table 9-8 (Continued)

2,700,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Reactor clarifier	1	$155,000	$155,000
	Chlorination/dechlorination mixing systems	1	$798,000	$798,000
	NaOH tanks	2	$10,000	$20,000
	Pump station 1	2	$9,000	$18,000
	Pump station 2	2	$10,500	$21,000
	Pump station 3	2	$10,500	$21,000
	Pump station 4	2	$10,500	$21,000
	Pump station 5	2	$11,000	$22,000
	pH adjust pumps	2	$2,200	$4,400
	Clarifier pumps	2	$5,500	$11,000
	NaOH pumps 1	2	$8,500	$17,000
	NaOH pumps 2	2	$3,500	$7,000
	Total freight			**$33,500**
	Subtotal			**$1,148,900**
Installation	**Mechanical equipment installation**			
	Reactor clarifier	1	$300,000	$300,000
	Chlorination/dechlorination mixing systems	1	$239,400	$239,400
	NaOH tanks	2	$1,000	$2,000
	Pump station 1	2	$2,500	$5,000
	Pump station 2	2	$2,500	$5,000
	Pump station 3	2	$2,500	$5,000
	Pump station 4	2	$2,500	$5,000
	Pump station 5	2	$2,500	$5,000
	pH adjust pumps	2	$2,000	$4,000
	Clarifier pumps	2	$2,000	$4,000
	NaOH pumps 1	2	$2,000	$4,000
	NaOH pumps 2	2	$2,000	$4,000

Table 9-8 (Continued)

2,700,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Piping installation**			
	Piping/supports	1	$191,200	$191,200
	Control valves/instrumentation	1	$33,700	$33,700
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	Reactor clarifier/clarifier pumps	1	$78,800	$78,800
	NaOH pumps	2	$3,500	$7,000
	NaOH tanks	1	$5,300	$5,300
	Chlorination mixing tank	2	$97,400	$194,800
	Chlorination system	1	$32,800	$32,800
	Retention tank	1	$1,000,800	$1,000,800
	Dechlorination mixing tank	2	$97,400	$194,800
	Dechlorination system	1	$11,500	$11,500
	pH adjust pumps	1	$3,500	$3,500
	Equalization basin	1	$657,400	$657,400
	Equipment structural support			
	Pump station 1 platform	1	$16,000	$16,000
	Pump station 2 platform	1	$16,000	$16,000
	Pump station 3 platform	1	$16,000	$16,000
	Pump station 4 platform	1	$16,000	$16,000
	Pump station 5 platform	1	$16,000	$16,000
	Buildings			
	Chlorination system	1	$6,000	$6,000
	Dechlorination system	1	$2,000	$2,000
	Electrical and process control			
	Power/equipment	1	$195,800	$195,800
	Control/instrumentation	1	$117,000	$117,000
	Building services	1	$1,500	$1,500
	Subtotal			**$3,396,300**

Table 9-8 (Continued)

2,700,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Indirect costs	Temporary facilities (1%)			$45,500
	Spare parts (1.5%)			$68,200
	Engineering procurement and contract management (12%)			$545,400
	Commissioning (3%)			$136,400
	Owner team (10%)			$454,500
	Subtotal			**$1,250,000**
Total costs	Total direct and indirect costs			$5,795,200
	Contingency (20%)			$1,159,000
	Total Project Cost			**$6,954,200**

Table 9-9

Design Specifications for Metals Precipitation Systems for Blast Furnace and Sintering Wastewater

Item	Type	150,000 gpd		750,000 gpd		2,000,000 gpd	
		Number	Size	Number	Size	Number	Size
Pump station 1	Vertical turbine	2 pumps	1/2 HP	2 pumps	3 HP	2 pumps	7.5 HP
Pump station 2	Vertical turbine	2 pumps	2 HP	2 pumps	10 HP	2 pumps	25 HP
Clarifier pump	Diaphragm/ANSI	2	1/3 HP (diaphragm)	2	1 HP (diaphragm)	2	1/2 HP (ANSI)
Filter press pump	Diaphragm	2	1/3 HP	2	1/3 HP	2	3 BHP
NaOH pump	ANSI	2	1/3 HP	2	1/2 HP	2	1.5 BHP
Acid pump	Diaphragm	2	1/3 HP	2	1/3 HP	2	3 BHP
Sump	Concrete	1	10 ft^3	1	40 ft^3	1	80 ft^3
Equalization basin	Concrete	1	5,100 ft^3	1	26,000 ft^3	1	67,000 ft^3
Reactor clarifier	Mild steel	1	15 ft diameter × 12 ft side/ 1 HP & 2.5 HP	1	35 ft diameter × 12 ft side/ 1 HP & 5 HP	1	51 ft diameter × 12 ft side/2 HP & 10 HP
Clarifier overflow	Concrete	1	450 ft^3	1	1,260 ft^3	1	14,000 ft^3
NaOH tank	Carbon steel	2	10 ft diameter × 10 ft side	2	10 ft diameter × 10 ft side	2	10 ft diameter × 10 ft side
Acid tank	FRP	2	10 ft diameter × 10 ft side	2	10 ft diameter × 10 ft side	2	10 ft diameter × 10 ft side
pH control tank	Stainless	1	90 ft^3/1HP	1	450 ft^3/1HP	1	1,200 ft^3/3 HP
Filter press	Pneumatic	1	18 ft × 7 ft × 6 ft/10 HP & 7.5 HP	1	18 ft × 7 ft × 6 ft/10 HP & 7.5 HP	1	18 ft × 7 ft × 6 ft/ 10 HP & 7.5 HP

FRP - Fiberglass, reinforced plastic.
ANSI - American National Standards Institute.

Table 9-10

Estimated Investment Costs for Metals Precipitations Systems for Blast Furnace and Sintering Wastewater (150,000 - 2,000,000 gpd)

150,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Reactor clarifier	1	$40,000	$40,000
	pH control tank	1	$8,900	$8,900
	Acid/NaOH tanks	4	$10,000	$40,000
	Filter press	1	$175,000	$175,000
	Pump station 1	2	$1,500	$3,000
	Pump station 2	2	$3,000	$6,000
	Clarifier pumps	2	$2,200	$4,400
	Filter press pumps	2	$2,200	$4,400
	NaOH pumps	2	$5,500	$11,000
	Acid pumps	2	$2,200	$4,400
	Total freight			**$8,900**
	Subtotal			**$306,000**
Installation	**Mechanical equipment installation**			
	Reactor clarifier	1	$110,000	$110,000
	pH control tank	1	$2,300	$2,300
	Acid/NaOH tanks	4	$1,000	$4,000
	Filter press	1	$52,500	$52,500
	Pump station 1	2	$1,500	$3,000
	Pump station 2	2	$1,500	$3,000
	Clarifier pumps	2	$2,000	$4,000
	Filter press pumps	2	$2,000	$4,000
	NaOH pumps	2	$1,500	$3,000
	Acid pumps	2	$2,000	$4,000

Table 9-10 (Continued)

150,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Piping installation**			
	Piping/supports	1	$78,500	$78,500
	Control valves/instrumentation	1	$13,800	$13,800
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	Reactor clarifier/overflow tank	1	$37,800	$37,800
	Clarifier pumps	1	$3,500	$3,500
	pH control tank	1	$1,800	$1,800
	Acid/NaOH tanks and pumps	1	$14,000	$14,000
	Filter press	1	$7,000	$7,000
	Equalization basin	1	$90,300	$90,300
	Sump/filter press pumps	1	$6,700	$6,700
	Equipment structural support			
	Pump station 1 platform	1	$2,000	$2,000
	Pump station 2 platform	1	$4,000	$4,000
	Electrical and process control			
	Power/equipment	1	$82,200	$82,200
	Control/instrumentation	1	$78,800	$78,800
	Subtotal			**$610,200**
Indirect costs	Temporary facilities (1%)			$9,200
	Spare parts (1.5%)			$13,700
	Engineering procurement and contract management (12%)			$109,900
	Commissioning (3%)			$27,500
	Owner team (10%)			$91,600
	Subtotal			**$251,900**
Total costs	Total direct and indirect costs			$1,168,100
	Contingency (20%)			$233,600
	Total Project Cost			**$1,401,700**

Table 9-10 (Continued)

750,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Reactor clarifier	1	$75,000	$75,000
	pH control tank	1	$23,500	$23,500
	Acid/NaOH tanks	4	$10,000	$40,000
	Filter press	1	$175,000	$175,000
	Pump station 1	2	$5,500	$11,000
	Pump station 2	2	$8,000	$16,000
	Clarifier pumps	2	$3,500	$7,000
	Filter press pumps	2	$2,200	$4,400
	NaOH pumps	2	$8,000	$16,000
	Acid pumps	2	$2,200	$4,400
	Total freight			**$11,200**
	Subtotal			**$383,500**
Installation	**Mechanical equipment installation**			
	Reactor clarifier	1	$162,000	$162,000
	pH control tank	1	$6,000	$6,000
	Acid/NaOH tanks	4	$1,000	$4,000
	Filter press	1	$52,500	$52,500
	Pump station 1	2	$2,000	$4,000
	Pump station 2	2	$2,000	$4,000
	Clarifier pumps	2	$2,000	$4,000
	Filter press pumps	2	$2,000	$4,000
	NaOH pumps	2	$1,500	$3,000
	Acid pumps	2	$2,000	$4,000
	Piping installation			
	Piping/supports	1	$114,000	$114,000
	Control valves/instrumentation	1	$20,100	$20,100

Table 9-10 (Continued)

750,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Civil/structural (includes costs associated with site preparation and grading)**			
	Equipment foundations			
	Reactor clarifier/overflow tank	1	$59,000	$59,000
	Clarifier pumps	1	$3,500	$3,500
	pH control tank	1	$5,300	$5,300
	Acid/NaOH tanks and pumps	1	$14,000	$14,000
	Filter press	1	$7,000	$7,000
	Equalization basin	1	$257,600	$257,600
	Sump/filter press pumps	1	$7,500	$7,500
	Equipment structural support			
	Pump station 1 platform	1	$4,000	$4,000
	Pump station 2 platform	1	$8,000	$8,000
	Electrical and process control			
	Power/equipment	1	$82,200	$82,200
	Control/instrumentation	1	$78,800	$78,800
	Subtotal			**$908,500**
Indirect costs	Temporary facilities (1%)			$12,900
	Spare parts (1.5%)			$19,400
	Engineering procurement and contract management (12%)			$155,000
	Commissioning (3%)			$38,800
	Owner team (10%)			$129,200
	Subtotal			**$355,300**
Total costs	Total direct and indirect costs			$1,647,300
	Contingency (20%)			$329,500
	Total Project Cost			**$1,976,700**

Table 9-10 (Continued)

2,000,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Reactor clarifier	1	$130,000	$130,000
	pH control tank	1	$47,400	$47,400
	Acid/NaOH tanks	4	$10,000	$40,000
	Filter press	1	$175,000	$175,000
	Pump station 1	2	$9,000	$18,000
	Pump station 2	2	$9,500	$19,000
	Clarifier pumps	2	$5,500	$11,000
	Filter press pumps	2	$2,200	$4,400
	NaOH pumps	2	$8,500	$17,000
	Acid pumps	2	$7,500	$15,000
	Total freight			**$14,300**
	Subtotal			**$491,100**
Installation	**Mechanical equipment installation**			
	Reactor clarifier	1	$253,000	$253,000
	pH control tank	1	$12,000	$12,000
	Acid/NaOH tanks	4	$10,000	$40,000
	Filter press	1	$52,500	$52,500
	Pump station 1	2	$2,500	$5,000
	Pump station 2	2	$2,500	$5,000
	Clarifier pumps	2	$1,500	$3,000
	Filter press pumps	2	$2,000	$4,000
	NaOH pumps	2	$2,000	$4,000
	Acid pumps	2	$2,000	$4,000
	Piping installation			
	Piping/supports	1	$139,200	$139,200
	Control valves/instrumentation	1	$24,600	$24,600

Table 9-10 (Continued)

2,000,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Civil/structural (includes costs associated with site preparation and grading)**			
	Equipment foundations			
	Reactor clarifier/overflow tank	1	$224,800	$224,800
	Clarifier pumps	1	$7,000	$7,000
	pH control tank	1	$10,500	$10,500
	Acid/NaOH tanks and pumps	1	$17,500	$17,500
	Filter press	1	$8,700	$8,700
	Equalization basin	1	$508,300	$508,300
	Sump/filter press pumps	1	$12,500	$12,500
	Equipment structural support			
	Pump station 1 platform	1	$6,000	$6,000
	Pump station 2 platform	1	$8,000	$8,000
	Electrical and process control			
	Power/equipment	1	$105,900	$105,900
	Control/instrumentation	1	$78,800	$78,800
	Subtotal			**$1,534,300**
Indirect costs	Temporary facilities (1%)			$20,300
	Spare parts (1.5%)			$30,400
	Engineering procurement and contract management (12%)			$243,000
	Commissioning (3%)			$60,800
	Owner team (10%)			$202,500
	Subtotal			**$557,000**
Total costs	Total direct and indirect costs			$2,582,400
	Contingency (20%)			$516,500
	Total Project Cost			**$3,098,900**

Table 9-11

Design Specifications for Alkaline Chlorination Systems for Blast Furnace and Sintering Wastewater

Item	Type	150,000 gpd		750,000 gpd		2,000,000 gpd	
		Number	Size	Number	Size	Number	Size
Pump station 1	Vertical turbine	2 pumps	1 HP	2 pumps	4 HP	2 pumps	10 HP
Pump station 2	Vertical turbine	2 pumps	1 HP	2 pumps	3 HP	2 pumps	7.5 HP
Pump station 3	Vertical turbine	2 pumps	1 HP	2 pumps	3 HP	2 pumps	7.5 HP
Pump station 4	Vertical turbine	2 pumps	1 HP	2 pumps	3 HP	2 pumps	7.5 HP
pH adjust pump	Diaphragm	2	3 HP	2	3 HP	2	3 HP
NaOH pump	Diaphragm	2	1/2 HP	2	1/2 HP	2	1/2 HP
Equalization basin	Concrete	1	5,100 ft^3	1	25,000 ft^3	1	67,000 ft^3
Chlorination mixing tank	Concrete	1	11 ft × 10 ft × 5 ft/5 HP	1	20 ft × 15 ft × 10 ft/20 HP	1	25 ft × 20 ft × 15 ft/3 @ 20 HP
Chlorination system	Building	1	10 ft × 9 ft × 20 ft/3 HP	1	10 ft × 9 ft × 20 ft/3 HP	1	15 ft × 20 ft × 20 ft/2 @ 3 HP
Retention tank	Concrete	1	50 ft × 11 ft × 10 ft	1	50 ft × 30 ft × 20 ft	1	80 ft × 50 ft × 20 ft
Dechlorination tank	Concrete	1	11 ft × 10 ft × 5 ft/5 HP	1	20 ft × 15 ft × 10 ft/20 HP	1	25 ft × 20 ft × 15 ft/3 @ 20 HP
Dechlorination system	Building/tank pad	1	8 ft × 8 ft × 15 ft/10 ft × 10 ft	1	8 ft × 8 ft × 15 ft/10 ft × 10 ft	1	8 ft × 8 ft × 15 ft/10 ft × 10 ft
NaOH tank	Carbon steel	2	10 ft diameter × 10 ft side	2	10 ft diameter × 10 ft side	2	10 ft diameter × 10 ft side

FRP - Fiberglass, reinforced plastic.
ANSI - American National Standards Institute.

Table 9-12

Estimated Investment Costs for Alkaline Chlorination Systems for Blast Furnace and Sintering Wastewater (150,000 - 2,000,000 gpd)

150,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Chlorination/dechlorination mixing systems	1	$44,700	$44,700
	NaOH tanks	2	$10,000	$20,000
	Pump station 1	2	$1,500	$3,000
	Pump station 2	2	$1,500	$3,000
	Pump station 3	2	$1,500	$3,000
	Pump station 4	2	$1,500	$3,000
	pH adjust pumps	2	$2,200	$4,400
	NaOH pumps	2	$2,200	$4,400
	Total freight			**$2,600**
	Subtotal			**$88,100**
Installation	**Mechanical equipment installation**			
	Chlorination/dechlorination mixing systems	1	$13,400	$13,400
	NaOH tanks	2	$1,000	$2,000
	Pump station 1	2	$1,500	$3,000
	Pump station 2	2	$1,500	$3,000
	Pump station 3	2	$1,500	$3,000
	Pump station 4	2	$1,500	$3,000
	pH adjust pumps	2	$2,000	$4,000
	NaOH pumps	2	$2,000	$4,000
	Piping installation			
	Piping/supports	1	$69,700	$69,700
	Control valves/instrumentation	1	$12,300	$12,300

Table 9-12 (Continued)

150,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Civil/structural (includes costs associated with site preparation and grading)**			
	Equipment foundations			
	NaOH pumps	1	$3,500	$3,500
	NaOH tanks	1	$4,200	$4,200
	Chlorination mixing tank	1	$25,100	$25,100
	Chlorination system	1	$12,600	$12,600
	Retention tank	1	$118,500	$118,500
	Dechlorination mixing tank	1	$25,100	$25,100
	Dechlorination system	1	$12,500	$12,500
	pH adjust pumps	1	$3,500	$3,500
	Equalization basin	1	$77,800	$77,800
	Equipment structural support			
	Pump station 1 platform	1	$4,000	$4,000
	Pump station 2 platform	1	$4,000	$4,000
	Pump station 3 platform	1	$4,000	$4,000
	Pump station 4 platform	1	$4,000	$4,000
	Buildings			
	Chlorination system	1	$2,000	$2,000
	Dechlorination system	1	$2,000	$2,000
	Electrical and process control			
	Power/equipment	1	$71,900	$71,900
	Control/instrumentation	1	$67,300	$67,300
	Building Services	1	$600	$600
	Subtotal			**$560,000**

Table 9-12 (Continued)

150,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Indirect costs	Temporary facilities (1%)			$6,500
	Spare parts (1.5%)			$9,700
	Engineering procurement and contract management (12%)			$77,800
	Commissioning (3%)			$19,400
	Owner team (10%)			$64,800
	Subtotal			**$178,200**
Total costs	Total direct and indirect costs			$826,300
	Contingency (20%)			$165,300
	Total Project Cost			**$991,600**

750,000 gallon per day				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Chlorination/dechlorination mixing systems	1	$223,500	$223,500
	NaOH tanks	2	$10,000	$20,000
	Pump station 1	2	$5,000	$10,000
	Pump station 2	2	$5,000	$10,000
	Pump station 3	2	$5,000	$10,000
	Pump station 4	2	$5,000	$10,000
	pH adjust pumps	2	$2,200	$4,400
	NaOH pumps	2	$2,200	$4,400
	Total freight			**$8,800**
	Subtotal			**$301,100**
Installation	**Mechanical equipment installation**			
	Chlorination/dechlorination mixing systems	1	$67,000	$67,000
	NaOH tanks	2	$1,000	$2,000
	Pump station 1	2	$2,000	$4,000
	Pump station 2	2	$2,000	$4,000
	Pump station 3	2	$2,000	$4,000
	Pump station 4	2	$2,000	$4,000
	pH adjust pumps	2	$2,000	$4,000
	NaOH pumps	2	$2,000	$4,000

Table 9-12 (Continued)

750,000 gallon per day				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Piping installation**			
	Piping/supports	1	$104,000	$104,000
	Control valves/instrumentation	1	$18,400	$18,400
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	NaOH pumps	1	$3,500	$3,500
	NaOH tanks	1	$4,200	$4,200
	Chlorination mixing tank	1	$64,800	$64,800
	Chlorination system	1	$12,600	$12,600
	Retention tank	1	$385,100	$385,100
	Dechlorination mixing tank	1	$64,800	$64,800
	Dechlorination system	1	$12,600	$12,600
	pH adjust pumps	1	$3,500	$3,500
	Equalization basin	1	$264,400	$264,400
	Equipment structural support			
	Pump station 1 platform	1	$8,000	$8,000
	Pump station 2 platform	1	$8,000	$8,000
	Pump station 3 platform	1	$8,000	$8,000
	Pump station 4 platform	1	$8,000	$8,000
	Buildings			
	Chlorination system	1	$2,000	$2,000
	Dechlorination system	1	$2,000	$2,000
	Electrical and process control			
	Power/equipment	1	$74,000	$74,000
	Control/instrumentation	1	$67,300	$67,300
	Building Services	1	$600	$600
	Subtotal			**$1,208,800**

Table 9-12 (Continued)

750,000 gallon per day				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Indirect costs	Temporary facilities (1%)			$15,100
	Spare parts (1.5%)			$22,600
	Engineering procurement and contract management (12%)			$181,200
	Commissioning (3%)			$45,300
	Owner team (10%)			$151,000
	Subtotal			**$415,200**
Total costs	Total direct and indirect costs			$1,925,100
	Contingency (20%)			$385,000
	Total Project Cost			**$2,310,100**

2,000,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Chlorination/dechlorination mixing systems	1	$590,100	$590,100
	NaOH tanks	2	$10,000	$20,000
	Pump station 1	2	$9,000	$18,000
	Pump station 2	2	$9,000	$18,000
	Pump station 3	2	$9,000	$18,000
	Pump station 4	2	$9,000	$18,000
	pH adjust pumps	2	$2,200	$4,400
	NaOH pumps	2	$2,200	$4,400
	Total freight			**$20,700**
	Subtotal			**$711,600**
Installation	**Mechanical equipment installation**			
	Chlorination/dechlorination mixing systems	1	$177,000	$177,000
	NaOH tanks	2	$1,000	$2,000
	Pump station 1	2	$2,500	$5,000
	Pump station 2	2	$2,500	$5,000
	Pump station 3	2	$2,500	$5,000
	Pump station 4	2	$2,500	$5,000
	pH adjust pumps	2	$2,000	$4,000
	NaOH pumps	2	$2,000	$4,000

Table 9-12 (Continued)

2,000,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Piping installation**			
	Piping/supports	1	$126,900	$126,900
	Control valves/instrumentation	1	$22,400	$22,400
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	NaOH pumps	1	$3,500	$3,500
	NaOH tanks	1	$4,200	$4,200
	Chlorination mixing tank	1	$120,300	$120,300
	Chlorination system	1	$31,100	$31,100
	Retention tank	1	$746,600	$746,600
	Dechlorination mixing tank	1	$120,300	$120,300
	Dechlorination system	1	$12,500	$12,500
	pH adjust pumps	1	$3,500	$3,500
	Equalization basin	1	$544,900	$544,900
	Equipment structural support			
	Pump station 1 platform	1	$16,000	$16,000
	Pump station 2 platform	1	$16,000	$16,000
	Pump station 3 platform	1	$16,000	$16,000
	Pump station 4 platform	1	$16,000	$16,000
	Buildings			
	Chlorination system	1	$6,000	$6,000
	Dechlorination system	1	$2,000	$2,000
	Electrical and process control			
	Power/equipment	1	$114,000	$114,000
	Control/instrumentation	1	$86,500	$86,500
	Building Services	1	$1,500	$1,500
	Subtotal			**$2,217,200**

Table 9-12 (Continued)

2,000,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Indirect costs	Temporary facilities (1%)			$29,300
	Spare parts (1.5%)			$43,900
	Engineering procurement and contract management (12%)			$351,500
	Commissioning (3%)			$87,900
	Owner team (10%)			$292,900
	Subtotal			**$805,500**
Total costs	Total direct and indirect costs			$3,734,400
	Contingency (20%)			$746,900
	Total Project Cost			**$4,481,300**

Table 9-13

Design Specifications for Metals Precipitation Systems for Basic Oxygen Furnace, Vacuum Degassing, and Continuous Casting Wastewater

Item	Type	150,000 gpd		750,000 gpd		2,000,000 gpd	
		Number	Size	Number	Size	Number	Size
Pump station 1	Vertical turbine	2 pumps	1/2 HP	2 pumps	3 HP	2 pumps	7.5 HP
Pump station 2	Vertical turbine	2 pumps	2 HP	2 pumps	10 HP	2 pumps	25 HP
Clarifier pumps	Diaphragm/ANSI	2 pumps	1/3 HP (diaphragm)	2 pumps	1 HP (diaphragm)	2 pumps	1/2 HP (ANSI)
NaOH pump	ANSI	2 pumps	1/3 HP	2 pumps	1/2 HP	2 pumps	1.5 BHP
Acid pump	Diaphragm	2 pumps	1/3 HP	2 pumps	1/3 HP	2 pumps	3 BHP
Equalization basin	Concrete	1	5,100 ft^3	1	26,000 ft^3	1	67,000 ft^3
Reactor clarifier	Mild Steel	1	15 ft diameter × 12 ft side/ 1 HP & 2.5 HP	1	35 ft diameter × 12 ft side/ 1 HP & 5 HP	1	51 ft diameter × 12 ft side/2 HP & 10 HP
Clarifier overflow	Concrete	1	450 ft^3/2 HP	1	1,260 ft^3/10 HP	1	14,000 ft^3/20 HP
NaOH tank	Carbon steel	2	10 ft diameter × 10 ft side	2	10 ft diameter × 10 ft side	2	10 ft diameter × 10 ft side
Acid tank	FRP	2	10 ft diameter × 10 ft side	2	10 ft diameter × 10 ft side	2	10 ft diameter × 10 ft side
pH control tank	Stainless	1	90 ft^3/1HP	1	450 ft^3/1HP	1	1200 ft^3/3 HP

FRP - Fiberglass, reinforced plastic.
ANSI - American National Standards Institute.

Table 9-14

Estimated Investment Costs for Metals Precipitation Systems for Basic Oxygen Furnace, Vacuum Degassing, and Continuous Casting Wastewater (150,000 - 2,000,000 gpd)

150,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Reactor clarifier	1	$40,000	$40,000
	pH control tank	1	$8,900	$8,900
	Acid/NaOH tanks	4	$10,000	$40,000
	Pump station 1	2	$1,500	$3,000
	Pump station 2	2	$3,000	$6,000
	Clarifier pumps	2	$2,200	$4,400
	NaOH pumps	2	$5,500	$11,000
	Acid pumps	2	$2,200	$4,400
	Total freight			**$3,500**
	Subtotal			**$121,200**
Installation	**Mechanical equipment installation**			
	Reactor clarifier	1	$110,000	$110,000
	pH control tank	1	$2,300	$2,300
	Acid/NaOH tanks	4	$1,000	$4,000
	Pump station 1	2	$1,500	$3,000
	Pump station 2	2	$1,500	$3,000
	Clarifier pumps	2	$2,000	$4,000
	NaOH pumps	2	$1,500	$3,000
	Acid pumps	2	$2,000	$4,000
	Piping installation			
	Piping/supports	1	$77,800	$77,800
	Control valves/instrumentation	1	$13,700	$13,700

Table 9-14 (Continued)

150,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Civil/structural (includes costs associated with site preparation and grading)**			
	Equipment foundations			
	Reactor clarifier/overflow tank	1	$37,800	$37,800
	Clarifier pumps	1	$3,500	$3,500
	pH control tank	1	$1,800	$1,800
	Acid/NaOH tanks and pumps	1	$14,000	$14,000
	Equalization basin	1	$90,300	$90,300
	Equipment structural support			
	Pump station 1 platform	1	$2,000	$2,000
	Pump station 2 platform	1	$4,000	$4,000
	Electrical and process control			
	Power/equipment	1	$68,400	$68,400
	Control/instrumentation	1	$63,500	$63,500
	Subtotal			**$510,000**
Indirect costs	Temporary facilities (1%)			$6,300
	Spare parts (1.5%)			$9,500
	Engineering procurement and contract management (12%)			$75,800
	Commissioning (3%)			$18,900
	Owner team (10%)			$63,100
	Subtotal			**$173,600**
Total costs	Total direct and indirect costs			$804,900
	Contingency (20%)			$161,000
	Total Project Cost			**$965,900**

Table 9-14 (Continued)

750,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Reactor clarifier	1	$75,000	$75,000
	pH control tank	1	$23,500	$23,500
	Acid/NaOH tanks	4	$10,000	$40,000
	Pump station 1	2	$5,500	$11,000
	Pump station 2	2	$8,000	$16,000
	Clarifier pumps	2	$3,500	$7,000
	NaOH pumps	2	$8,000	$16,000
	Acid pumps	2	$2,200	$4,400
	Total freight			**$5,800**
	Subtotal			**$198,700**
Installation	**Mechanical equipment installation**			
	Reactor clarifier	1	$162,000	$162,000
	pH control tank	1	$6,000	$6,000
	Acid/NaOH tanks	4	$1,000	$4,000
	Pump station 1	2	$2,000	$4,000
	Pump station 2	2	$2,000	$4,000
	Clarifier pumps	2	$2,000	$4,000
	NaOH pumps	2	$1,500	$3,000
	Acid pumps	2	$2,000	$4,000
	Piping installation			
	Piping/supports	1	$113,300	$113,300
	Control valves/instrumentation	1	$20,000	$20,000
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	Reactor clarifier/overflow tank	1	$59,000	$59,000
	Clarifier pumps	1	$3,500	$3,500
	pH control tank	1	$5,300	$5,300
	Acid/NaOH tanks and pumps	1	$14,000	$14,000
	Equalization basin	1	$257,700	$257,700

Table 9-14 (Continued)

750,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Equipment structural support**			
	Pump station 1 platform	1	$4,000	$4,000
	Pump station 2 platform	1	$8,000	$8,000
	Electrical and process control			
	Power/equipment	1	$68,400	$68,400
	Control/instrumentation	1	$63,500	$63,500
	Subtotal			**$807,700**
Indirect costs	Temporary facilities (1%)			$10,100
	Spare parts (1.5%)			$15,100
	Engineering procurement and contract management (12%)			$120,800
	Commissioning (3%)			$30,200
	Owner team (10%)			$100,600
	Subtotal			**$276,800**
Total costs	Total direct and indirect costs			$1,283,200
	Contingency (20%)			$256,600
	Total Project Cost			**$1,539,800**

2,000,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Reactor clarifier	1	$130,000	$130,000
	pH control tank	1	$47,400	$47,400
	Acid/NaOH tanks	4	$10,000	$40,000
	Pump station 1	2	$9,000	$18,000
	Pump station 2	2	$9,500	$19,000
	Clarifier pumps	2	$5,500	$11,000
	NaOH pumps	2	$8,500	$17,000
	Acid pumps	2	$7,500	$15,000
	Total freight			**$8,900**
	Subtotal			**$306,300**

Table 9-14 (Continued)

2,000,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation	**Mechanical equipment installation**			
	Reactor clarifier	1	$253,000	$253,000
	pH control tank	1	$12,000	$12,000
	Acid/NaOH tanks	4	$10,000	$40,000
	Pump station 1	2	$2,500	$5,000
	Pump station 2	2	$2,500	$5,000
	Clarifier pumps	2	$1,500	$3,000
	NaOH pumps	2	$2,000	$4,000
	Acid pumps	2	$2,000	$4,000
	Piping installation			
	Piping/supports	1	$92,100	$92,100
	Control valves/instrumentation	1	$63,500	$63,500
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	Reactor clarifier/overflow tank	1	$224,800	$224,800
	Clarifier pumps	1	$7,000	$7,000
	pH control tank	1	$10,500	$10,500
	Acid/NaOH tanks and pumps	1	$17,500	$17,500
	Equalization basin	1	$508,300	$508,300
	Equipment structural support			
	Pump station 1 platform	1	$6,000	$6,000
	Pump station 2 platform	1	$8,000	$8,000
	Electrical and process control			
	Power/equipment	1	$92,100	$92,100
	Control/instrumentation	1	$63,500	$63,500
	Subtotal			**$1,419,300**

Table 9-14 (Continued)

2,000,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Indirect costs	Temporary facilities (1%)			$17,300
	Spare parts (1.5%)			$25,900
	Engineering procurement and contract management (12%)			$207,100
	Commissioning (3%)			$51,800
	Owner team (10%)			$172,600
	Subtotal			**$474,700**
Total costs	Total direct and indirect costs			$2,200,300
	Contingency (20%)			$440,100
	Total Project Cost			**$26,401,400**

Table 9-15

Design Specifications for Multimedia Filtration Systems

Item	Type	150,000 gpd		500,000 gpd		2,000,000 gpd		7,500,000 gpd		20,000,000 gpd	
		Number	Size	Number	Size	Number	Size	Number	Size	Number	Size
Pump station 1	Horizontal split	2 pumps	1.5 HP	2 pumps	5 HP	2 pumps	20 HP	2 pumps	25 HP	2 pumps	60 HP
Pump station 2	Diaphragm/ Vertical turbine[a]	2 pumps	3 HP	2 pumps	3 HP	2 pumps	1 HP	2 pumps	3 HP	2 pumps	3 HP
Filter backwash pump	Vertical turbine	2	1.5 HP	2	3 HP	2	10 HP	2	10 HP	2	20 HP
Sump 1	Concrete	1	450 ft^3	1	800 ft^3	1	3,000 ft^3	1	3,000 ft^3	1	6,000 ft^3
Filter backwash surge basin	Concrete	1	450 ft^3	1	800 ft^3	1	3,000 ft^3	1	3,000 ft^3	1	6,000 ft^3
Filtration system	Sand pressure	2	6 ft diameter × 9 ft side/ 7.5 HP	2	8 ft diameter × 9 ft side/ 7.5 HP	2	12 ft diameter × 9 ft side/ 20 HP	8	12 ft diameter × 9 ft side/ 20 HP	8	16' diam. × 9' side/ 60 HP

[a]Diaphragm pumps (150,000 gpd - 500,000 gpd); vertical turbine pumps (2,000,000 - 20,000,000 gpd).

Table 9-16

Estimated Investment Costs for Multimedia Filtration Systems (150,000 - 20,000,000 gallons per day)

150,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Filters	2	$100,000	$200,000
	Pump station 1	2	$1,500	$3,000
	Pump station 2	2	$2,200	$4,400
	Filter backwash pumps	2	$3,000	$6,000
	Total freight			**$6,400**
	Subtotal			**$219,800**
Installation	**Mechanical equipment installation**			
	Filters	2	$11,000	$22,000
	Pump station 1	2	$1,500	$3,000
	Pump station 2	2	$2,000	$4,000
	Filter backwash pumps	2	$1,500	$3,000
	Piping installation			
	Piping/supports	1	$82,800	$82,800
	Control valves/instrumentation	1	$14,600	$14,600
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	Filtration plant	1	$81,900	$81,900
	Sump 1	1	$19,000	$19,000
	Filter backwash surge basin	1	$19,000	$19,000
	Equipment structural support			
	Pump station 1 platform	1	$3,500	$3,500
	Pump station 2 platform	1	$4,000	$4,000
	Filter backwash pumps	1	$4,000	$4,000
	Buildings			
	Filtration plant	1	$24,500	$24,500

Table 9-16 (Continued)

150,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Electrical and process control**			
	Power/equipment	1	$43,600	$43,600
	Control/instrumentation	1	$40,600	$40,600
	Building services	1	$5,100	$5,100
	Subtotal			**$374,600**
Indirect costs	Temporary facilities (1%)			$6,000
	Spare parts (1.5%)			$8,900
	Engineering procurement and contract management (12%)			$71,300
	Commissioning (3%)			$17,300
	Owner team (10%)			$59,400
	Subtotal			**$163,400**
Total costs	Total direct and indirect costs			$757,800
	Contingency (20%)			$151,600
	Total Project Cost			**$909,400**

500,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Filters	2	$105,000	$210,000
	Pump station 1	2	$5,000	$10,000
	Pump station 2	2	$3,500	$7,000
	Filter backwash pumps	2	$5,000	$10,000
	Total freight			**$7,100**
	Subtotal			**$244,100**
Installation	**Mechanical equipment installation**			
	Filters	2	$13,000	$26,000
	Pump station 1	2	$2,000	$4,000
	Pump station 2	2	$2,000	$4,000
	Filter backwash pumps	2	$1,500	$3,000

Table 9-16 (Continued)

500,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Piping installation**			
	Piping/supports	1	$98,600	$98,600
	Control valves/instrumentation	1	$17,400	$17,400
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	Filtration plant	1	$97,800	$97,800
	Sump 1	1	$22,000	$22,000
	Filter backwash surge basin	1	$22,000	$22,000
	Equipment structural support			
	Pump station 1 platform	1	$7,000	$7,000
	Pump station 2 platform	1	$4,000	$4,000
	Filter backwash pumps	1	$4,000	$4,000
	Buildings			
	Filtration plant	1	$28,000	$28,000
	Electrical and process control			
	Power/equipment	1	$43,600	$43,600
	Control/instrumentation	1	$40,600	$40,600
	Building services	1	$5,800	$5,800
	Subtotal			**$427,800**
Indirect costs	Temporary facilities (1%)			$6,700
	Spare parts (1.5%)			$10,100
	Engineering procurement and contract management (12%)			$80,600
	Commissioning (3%)			$20,200
	Owner team (10%)			$67,200
	Subtotal			**$184,800**
Total costs	Total direct and indirect costs			$856,700
	Contingency (20%)			$171,300
	Total Project Cost			**$1,028,000**

Table 9-16 (Continued)

2,000,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Filters	2	$107,500	$215,000
	Pump station 1	2	$9,000	$18,000
	Pump station 2	2	$1,500	$3,000
	Filter backwash pumps	2	$9,000	$18,000
	Total freight			**$7,600**
	Subtotal			**$261,600**
Installation	**Mechanical equipment installation**			
	Filters	2	$12,000	$24,000
	Pump station 1	2	$2,500	$5,000
	Pump station 2	2	$1,500	$3,000
	Filter backwash pumps	2	$2,000	$4,000
	Piping installation			
	Piping/supports	1	$161,400	$161,400
	Control valves/instrumentation	1	$28,500	$28,500
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	Filtration plant	1	$212,300	$212,300
	Sump 1	1	$53,200	$53,200
	Filter backwash surge basin	1	$53,200	$53,200
	Equipment structural support			
	Pump station 1 platform	1	$10,500	$10,500
	Pump station 2 platform	1	$4,000	$4,000
	Filter backwash pumps	1	$8,000	$8,000
	Buildings			
	Filtration plant	1	$60,000	$60,000
	Electrical and process control			
	Power/equipment	1	$68,800	$68,800
	Control/instrumentation	1	$44,400	$44,400
	Building services	1	$12,500	$12,500
	Subtotal			**$752,800**

Table 9-16 (Continued)

2,000,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Indirect costs	Temporary facilities (1%)			$10,100
	Spare parts (1.5%)			$15,200
	Engineering procurement and contract management (12%)			$121,700
	Commissioning (3%)			$30,400
	Owner team (10%)			$101,400
	Subtotal			**$278,800**
Total costs	Total direct and indirect costs			$1,293,200
	Contingency (20%)			$258,600
	Total Project Cost			**$1,551,800**

7,500,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Filters	8	$107,500	$860,000
	Pump station 1	2	$9,000	$18,000
	Pump station 2	2	$5,000	$10,000
	Filter backwash pumps	2	$9,000	$18,000
	Total freight			**$27,200**
	Subtotal			**$933,200**
Installation	**Mechanical equipment installation**			
	Filters	8	$12,000	$96,000
	Pump station 1	2	$2,500	$5,000
	Pump station 2	2	$2,000	$4,000
	Filter backwash pumps	2	$2,500	$5,000
	Piping installation			
	Piping/supports	1	$258,500	$258,500
	Control valves/instrumentation	1	$45,600	$45,600
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	Filtration plant	1	$337,200	$337,200
	Sump 1	1	$53,200	$53,200
	Filter backwash surge basin	1	$53,200	$53,200

Table 9-16 (Continued)

7,500,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation (cont.)	**Equipment structural support**			
	Pump station 1 platform	1	$10,500	$10,500
	Pump station 2 platform	1	$4,000	$4,000
	Filter backwash pumps	1	$8,000	$8,000
	Buildings			
	Filtration plant	1	$95,000	$95,000
	Electrical and process control			
	Power/equipment	1	$130,300	$130,300
	Control/instrumentation	1	$63,500	$63,500
	Building services	1	$19,800	$19,800
	Subtotal			**$1,188,800**
Indirect costs	Temporary facilities (1%)			$21,200
	Spare parts (1.5%)			$31,800
	Engineering procurement and contract management (12%)			$254,600
	Commissioning (3%)			$63,700
	Owner team (10%)			$212,200
	Subtotal			**$583,500**
Total costs	Total direct and indirect costs			$2,705,500
	Contingency (20%)			$541,100
	Total Project Cost			**$32,466,000**

20,000,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Major equipment	Filters	8	$107,500	$860,000
	Pump station 1	2	$25,000	$50,000
	Pump station 2	2	$5,000	$10,000
	Filter backwash pumps	2	$10,000	$20,000
	Total freight			**$28,200**
	Subtotal			**$968,200**

Table 9-16 (Continued)

20,000,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Installation	**Mechanical equipment installation**			
	Filters	8	$12,000	$96,000
	Pump station 1	2	$4,000	$8,000
	Pump station 2	2	$2,000	$4,000
	Filter backwash pumps	2	$4,000	$8,000
	Piping installation			
	Piping/supports	1	$417,300	$417,300
	Control valves/instrumentation	1	$73,600	$73,600
	Civil/structural (includes costs associated with site preparation and grading)			
	Equipment foundations			
	Filtration plant	1	$466,700	$466,700
	Sump 1	1	$83,600	$83,600
	Filter backwash surge basin	1	$83,600	$83,600
	Equipment structural support			
	Pump station 1 platform	1	$14,000	$14,000
	Pump station 2 platform	1	$14,000	$14,000
	Filter backwash pumps	1	$10,000	$10,000
	Buildings			
	Filtration plant	1	$132,000	$132,000
	Electrical and process control			
	Power/equipment	1	$177,100	$177,100
	Control/instrumentation	1	$63,500	$63,500
	Building services	1	$27,500	$27,500
	Subtotal			**$1,678,900**
Indirect costs	Temporary facilities (1%)			$26,500
	Spare parts (1.5%)			$39,700
	Engineering procurement and contract management (12%)			$317,600
	Commissioning (3%)			$79,400
	Owner team (10%)			$264,700
	Subtotal			**$727,900**

Table 9-16 (Continued)

20,000,000 gpd				
Category	**Item**	**Quantity**	**Rate**	**Cost**
Total costs	Total direct and indirect costs			$3,375,000
	Contingency (20%)			$675,000
	Total Project Cost			**$4,050,000**

Table 9-17

Summary of Costs for the Cokemaking Subcategory (in millions of 1997 dollars)

Option	Investment Cost	Operating and Maintenance Cost	One-Time Cost
BAT-1	8.0	0.1	0.3
BAT-2	12.4	3.0	0.3
BAT-3	42.3	7.2	0.3
BAT-4	66.5	14.9	0.3
PSES-1	0	0.3	0.2
PSES-2	6.0	1.8	0.2
PSES-3	18.6	3.3	0.2
PSES-4	32.1	5.8	0.2

Table 9-18

Summary of Costs for the Ironmaking Subcategory (in millions of 1997 dollars)

Options	Investment Cost	Operating and Maintenance Cost	One-Time Cost
BAT-1 and PSES-1	25.8	2.7	0.7

Table 9-19

Summary of Costs for the Integrated Steelmaking Subcategory (in millions of 1997 dollars)

Options	Investment Cost	Operating and Maintenance Cost	One-Time Cost
BAT-1 and PSES-1	16.8	2.9	2.1

Table 9-20

Summary of Costs for the Integrated and Stand-Alone Hot Forming Subcategory (in millions of 1997 dollars)

Option	Investment Cost	Operating and Maintenance Cost	One-Time Cost
Carbon and Alloy Segment			
BAT-1	115.3	16.1	1.0
PSES-1	0.3	0.1	0.1
Stainless Segment[a]			
PSES-1	1.1	0.2	0.1

[a]No sites reported direct discharge of wastewater within the Stainless Segment.

Table 9-21

Summary of Costs for the Non-integrated Steelmaking and Hot Forming Subcategory (in millions of 1997 dollars)

Option	Investment Cost	Operating and Maintenance Cost	One-Time Cost
Carbon and Alloy Segment			
BAT-1	18.9	2.0	3.9
PSES-1	2.5	0.4	0.8
Stainless Segment			
BAT-1	0.4	0.1	0.2
BAT-2	3.7	0.6	0.2
PSES-1	0	0	0.4

Table 9-22

Summary of Costs for the Steel Finishing Subcategory (in millions of 1997 dollars)

Option	Investment Cost	Operating and Maintenance Cost	One-Time Cost
Carbon and Alloy Segment			
BAT-1	16.0	2.5	1.6
PSES-1	6.0	1.2	0.8
Stainless Segment			
BAT-1	16.4	(1.1)	0.8
PSES-1	4.0	0.2	0.4

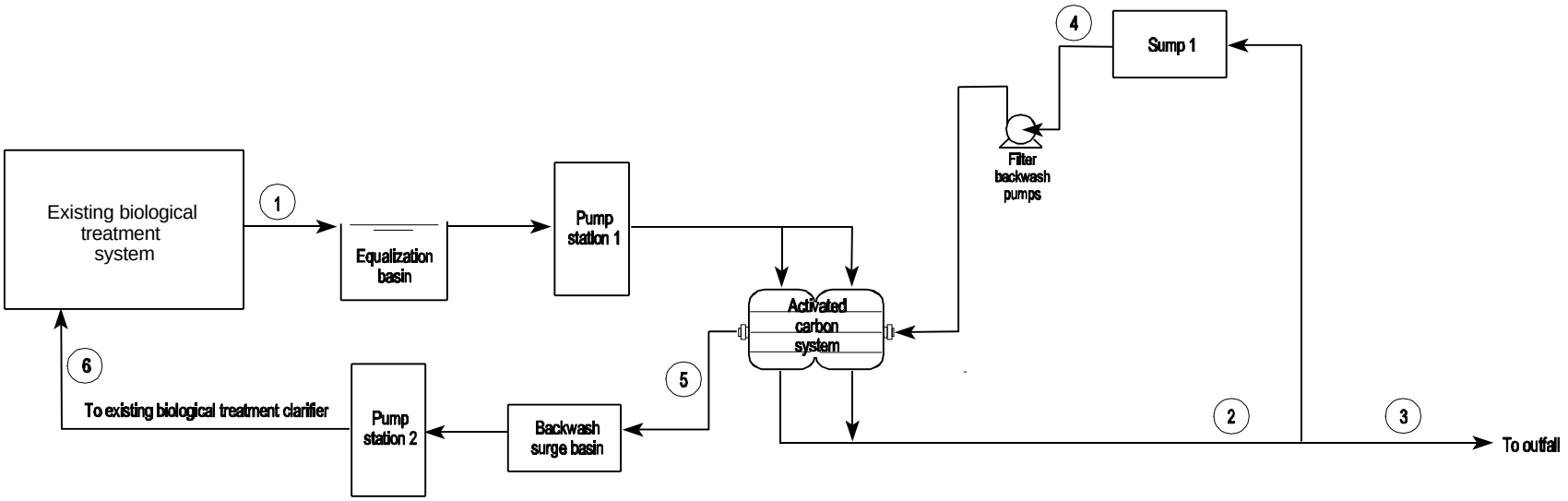
( ) Indicates a cost savings.

Table 9-23

Summary of Costs for the Other Operations Subcategory (in millions of 1997 dollars)

Option	Investment Cost	Operating and Maintenance Cost	One-Time Cost
Direct Reduced Ironmaking Segment			
BPT	[a]	[a]	[a]
Forging Segment			
BPT	0	0	0.1

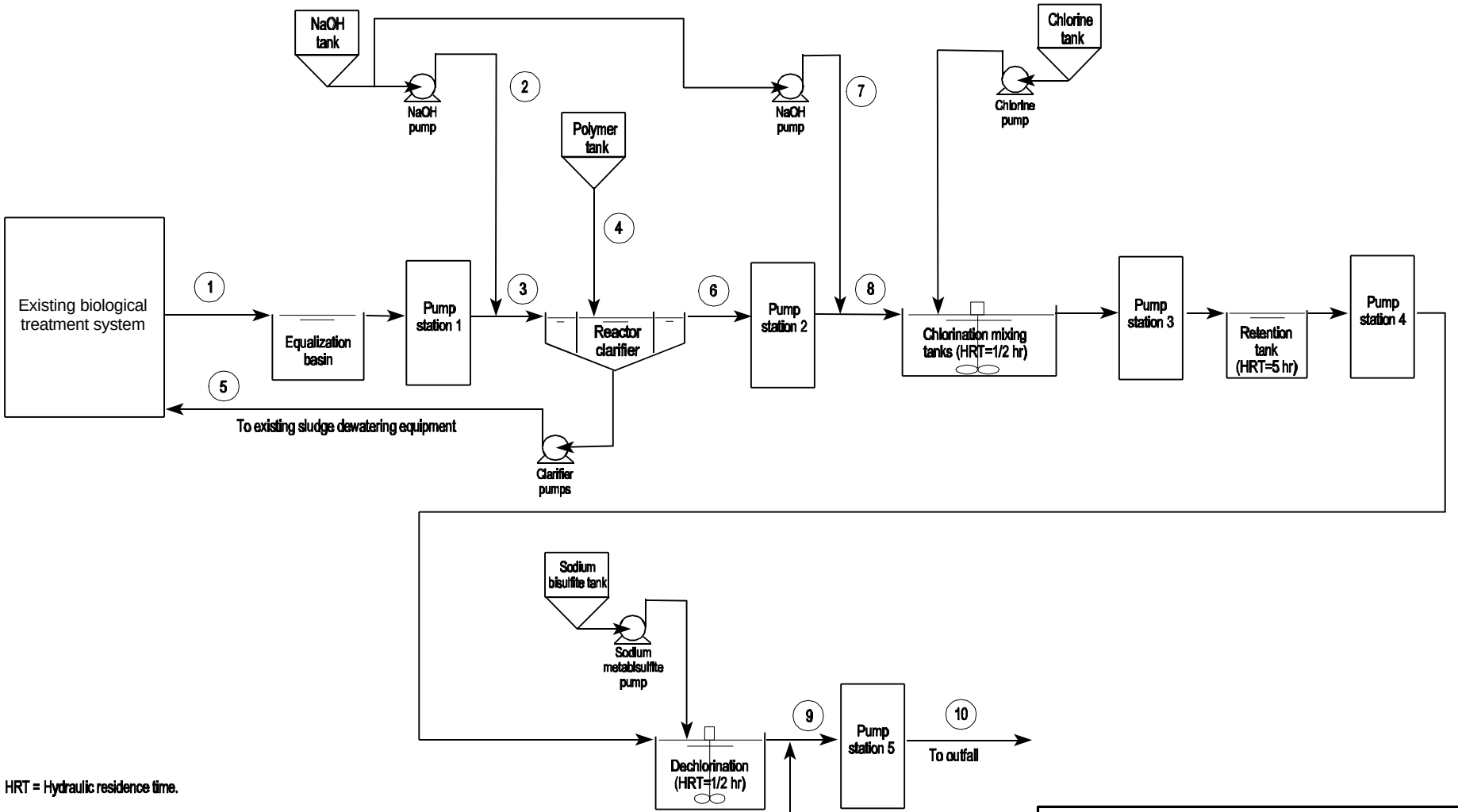
[a]Data aggregation or other masking techniques are insufficient to protect confidential business information.



System Flows (gpm)						
Design Influents	1	2	3	4	5	6
100,000 gpd	70	70	52	9 (avg) 225 (max)	9 (avg) 225 (max)	9
400,000 gpd	280	280	250	15 (avg) 350 (max)	15 (avg) 350 (max)	15
2,700,000 gpd	1875	1875	1625	125 (avg) 1500 (max)	125 (avg) 1500 (max)	125

Figure 9-1. Activated Carbon Treatment for By-Products Recovery Cokemaking Wastewater

GAC	10/27/00	EPA

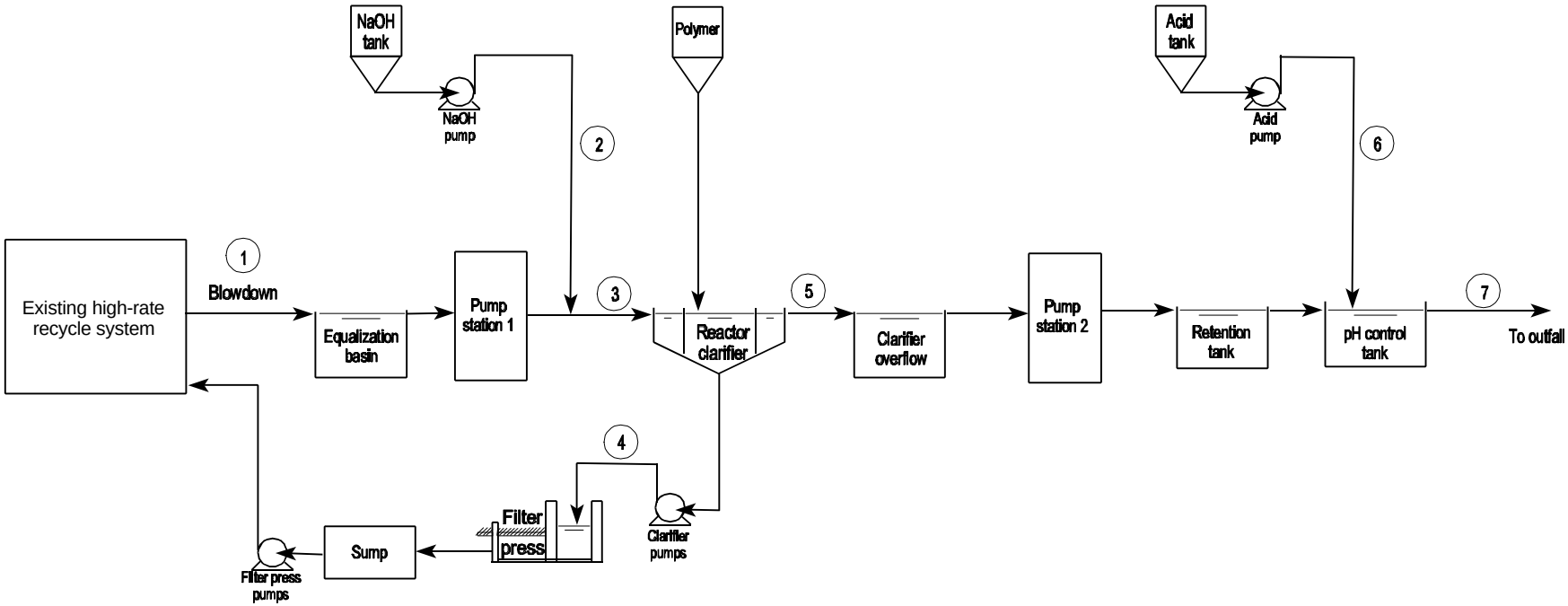


HRT = Hydraulic residence time.

System Flows (gpm)										
Design Influents	1	2	3	4	5	6	7	8	9	10
150,000 gpd	70	19	89	1	3	87	1	88	88	88
750,000 gpd	280	75	355	3	10	348	5	353	353	353
2,000,000 gpd	1875	500	2375	5	70	2310	30	2340	2340	2340

Figure 9-2. Alkaline Chlorination for By-Products Recovery Cokemaking Wastewater

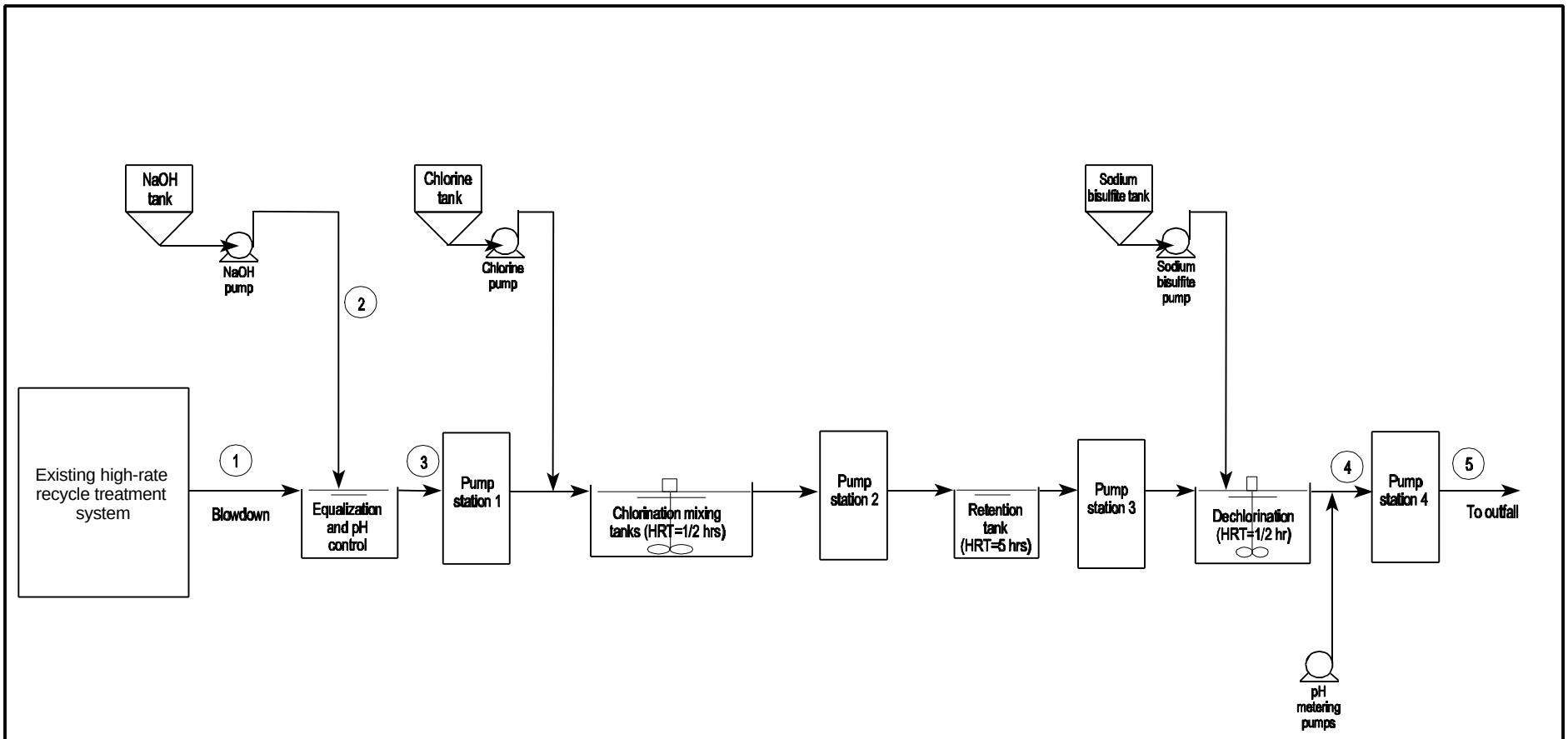
COKE	10/20/00	EPA



System Flows (gpm)							
Design Influents	1	2	3	4	5	6	7
150,000 gpd	105	30	135	5	130	2	132
750,000 gpd	525	140	665	20	645	10	655
2,000,000 gpd	1390	370	1760	40	1720	30	1750

Figure 9-3. Blowdown Metals Precipitation for Ironmaking Wastewater

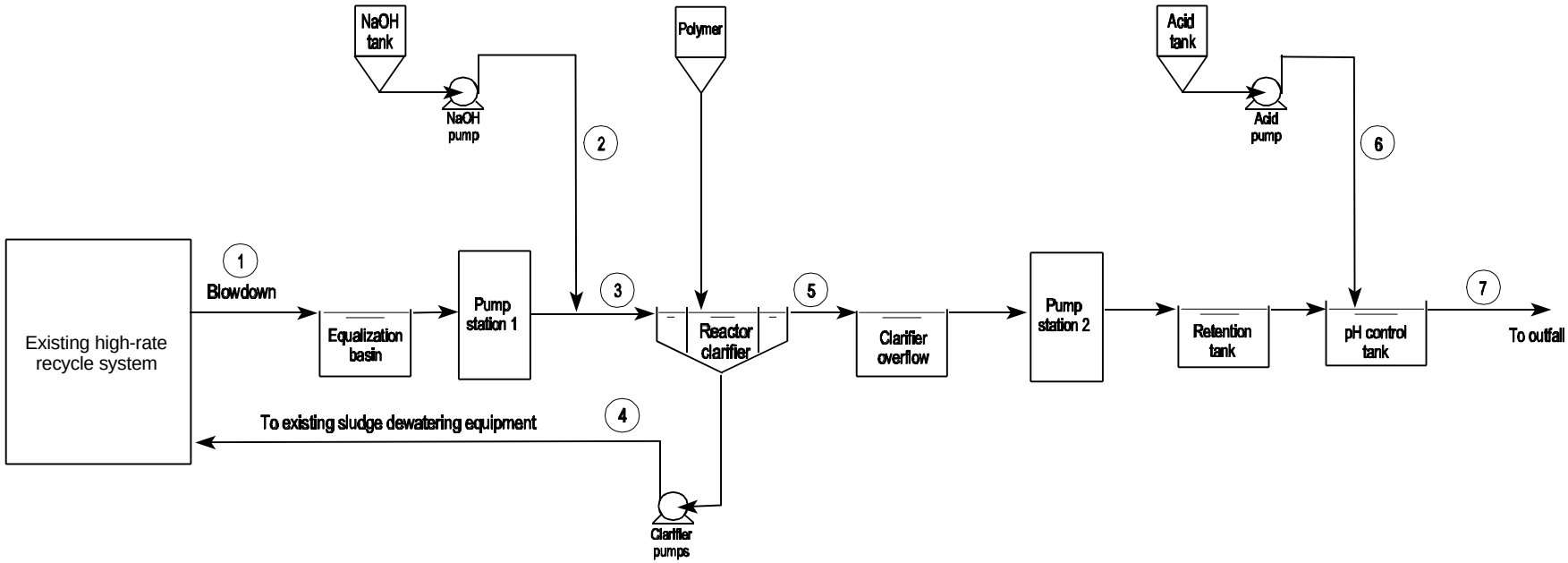
IRNMAK | 10/20/00 | EPA



System Flows (gpm)					
Design Influents	1	2	3	4	5
150,000 gpd	105	5	110	110	110
750,000 gpd	525	10	535	535	535
2,000,000 gpd	1390	25	1415	1415	1415

Figure 9-4. Alkaline Chlorination for Ironmaking Wastewater

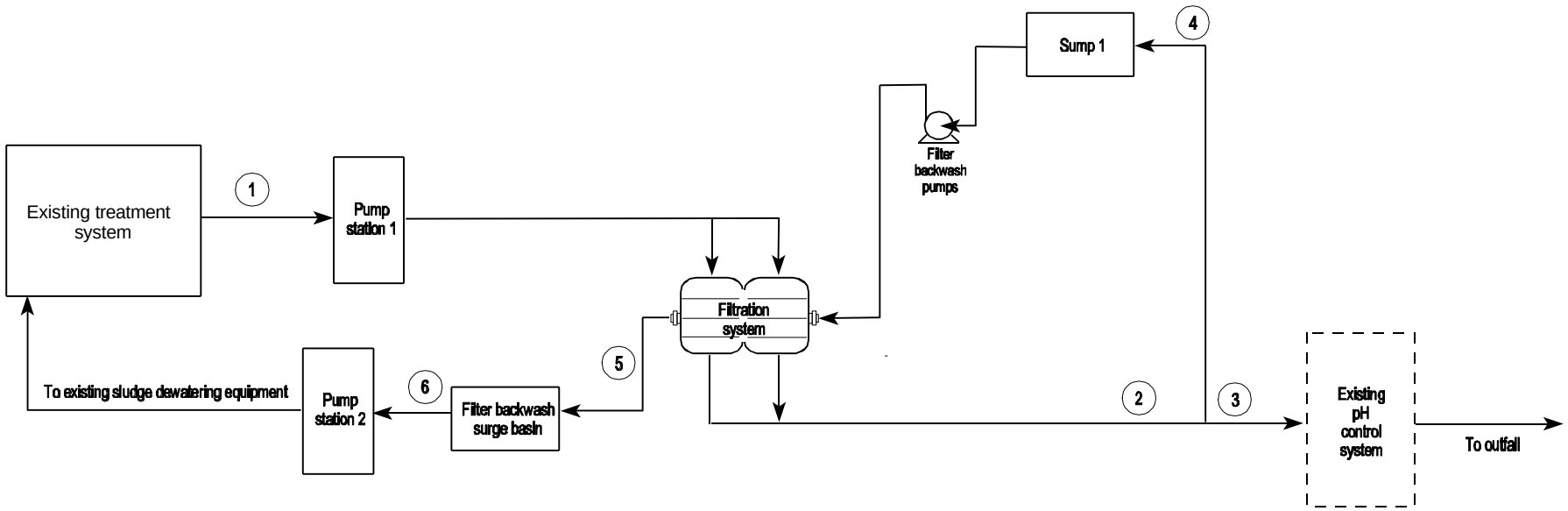
IRNMAK | 10/20/00 | EPA



System Flows (gpm)							
Design Influents	1	2	3	4	5	6	7
150,000 gpd	105	30	135	5	130	2	132
750,000 gpd	525	140	665	20	645	10	655
2,000,000 gpd	1390	370	1760	40	1720	30	1750

Figure 9-5. Blowdown Metals Precipitation for Steelmaking Wastewater

STEEL | 10/20/00 | EPA



System Flows (gpm)						
Design Influents	1	2	3	4	5	6
150,000 gpd	105	105	95	10 (avg) 226 (max)	10 (avg) 226 (max)	10
500,000 gpd	350	350	333	17 (avg) 402 (max)	17 (avg) 402 (max)	17
2,000,000 gpd	1390	1390	1265	125 (avg) 1500 (max)	125 (avg) 1500 (max)	125
7,500,000 gpd	5200	5200	4870	330 (avg) 1500 (max)	330 (avg) 1500 (max)	330
20,000,000 gpd	13900	13900	13230	670 (avg) 3000 (max)	670 (avg) 3000 (max)	670

Figure 9-6. Filtration of Wastewater from All Subcategories

FILT	10/22/00	EPA